

THE CONTENTS OF THIS SECTION ARE
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INITIAL BC DATE 4/24/03

Appendix A

Assay Test Data on Advanced Test Reactor Beryllium Purchased from Kawecki Berylco Industries

A-2

Appendix A

Assay Test Data on Advanced Test Reactor Beryllium Purchased from Kawecki Berylco Industries

Appendix A contains copies of test reports on Kawecki beryllium found in archived records at the INEEL.

CUSTOMER: Mechanical Spec. Co.	KAWECKI BERYLCO INDUSTRIES, INC.			DATE May 30, 1978
CUSTOMER LOCATION: Los Angeles, Ca.	POST OFFICE BOX 429 HAZLETON, PENNSYLVANIA 18201			BERYLCO ORDER NO. 58-4359
CUSTOMER P. O. NUMBER: Mech. Spec. P.O. S51668 E.G. & G. P.O. K2557	QUALITY CONTROL MATERIAL TEST REPORT			SPEC. NUMBERS ANC-80005F

DESCRIPTION

One (1) Blank Per ANC Drawing 403228-1 Rev. B (HA 5470)K.B.I. Unit No. 25-1001 Hot Pressing No. 616AE.G. & G. S/N 021

NUMBER	616A	Element	616A	Element	616A
Be Assay	98.37	Pb	<0.0001	Lu	<0.00005
BeO	1.96	Si	0.0330	Sc	0.00017
C	0.065	Mo	<0.0010		
Fe	0.1160	Tl	0.0065		
Al	0.0255	B	0.00015		
Mg	0.0015	Cd	<0.0001		
Si	0.0045	Li	<0.0001		
Mn	0.0180	F	0.0070		
Ni	0.0065	Cl	<0.0050		
Cr	0.0200	Br	0.0021		
Ca	0.0016	I	<0.0010		
Co	0.0075	In	<0.0001		
Cu	0.0100	Ce	<0.0001		
Zn	0.0003	Pr	<0.0001		
Ag		Nd	<0.0005		
U.T.S.		Sm	<0.00005		
.2% Y.S.		Eu	<0.00005		
% El.		Gd (Cd)	<0.00002		
		Tb	<0.0001		
		Dy	<0.00002	M. S. C. MATERIAL	
		Ho	<0.0001	CODE NO.	E-35
		Er	<0.00005		
		Tm	<0.00005		
DENSITY		Yb	<0.00002		

T-Count 10.654×10^{-6}

Sieve analysis of powder lot 5133 used to produce unit 25-1001. Pressing 616A was 99.9 % minus 200 mesh (ASTM B-214)

Total danger sum (Para. 3.3.2) = 31.65 (For elements listed at less than the detection limit, the detection limit has been used for calculating the total danger sum)

Two (2) 50 gram samples for customer per Para. 4.2.1/4.2.2. are enclosed to this report.

1

KAWECKI BERYLCO INDUSTRIES, INC.
P.O. BOX 429, HAZLETON, PA. 18201By Edward A. PashTitle O. C. Super

KAWECKI BERYLCO INDUSTRIES, INC.



P. O. Box 429, Hazleton, Pa. 18201
Telephone: 717 / 455-4913

Date June 20, 1973

Mech Spec. P.O. # S51668
KBI P.O. # 58-4359
Dwg # 403228-1 Rev B
Material Specification ANC-80005G
ATR Beryllium Reflector Material Blank
Pressing # 612A E. G. & G. S/N 022
642A

6.
Reviewed
by

Certification Contents

1. Chemical Composition
2. Mechanical Properties
3. Mechanical Properties Stress Strain Charts
4. Physical Properties - Density etc.
5. Radiographic Report
6. Dimensional Report
7. Liquid Penetrant Report
8. Certification of Material Compliance
9. In-Process Routing of Segment
10. In-Process Routing of Mechanical Test Specimens
11. In-Process operational sketches
12. Beryllium Powder Release

Remarks:

Edward H. Rash
Edward H. Rash
KBI Q. C. Supervisor

METALS • ALLOYS • CHEMICALS

M. S. C. MATERIAL
CODE NO. E-38

CUSTOMER, Mechanical Specialties Co.	KAWECKI BERYLCO INDUSTRIES, INC. POST OFFICE BOX 429 HAZLETON, PENNSYLVANIA 18201	DATE June 30, 1978
STOMER LOCATION Los Angeles, Ca.		BERYLCO ORDER NO. 58-1359
CUSTOMER P. O. NUMBER Mech Spec. P.O. S51668 E.G & G. P.O. K2557		SPEC. NUMBERS ANC-80005 B
QUALITY CONTROL MATERIAL TEST REPORT		

DESCRIPTION
One (1) Pcs., Kawecki Berylco Be Segment Blank per Drawing # 403228-1 Rev B (PA-5/70)
KBE Unit No - 25-1002 Hot Pressing No - 6/2A

E. G. & G. S/N - 022

NUMBER	6/2A						
Be Assay	98.10			Pt	<0.0002		
BeO	1.89			T	<0.0000		
C	0.051			Ia	<0.0001		
Fe	0.1500			Ca	<0.0001		
Al	0.0245			Pt	<0.0001		
Mg	0.0010			Nd	<0.0005		
Si	0.0233			Sm	<0.00005		
Mn	0.0015			Va	<0.00005		
Cr	0.0100			Cd	<0.00001		
Ca	< 0.0200			Tb	<0.0001		
	0.0019			Dy	<0.00002		
Zn	< 0.0100			Ho	<0.0001		
As	0.0015			Er	<0.00005		
U.T.S.	Pb	< 0.0001		Tm	<0.00005		
	Si	0.0010		Yb	<0.00002		
.2% Y.S.	No	< 0.0010		Lu	<0.00005		
	Ti	0.0015		Sc	<0.00005		
% El.	R	0.00015					
	Cr	< 0.0001					
	I	< 0.0001					
	F	0.0010					
	Cl	< 0.0010					
DENSITY	1.851 g/cc						

M. S. C. MATERIAL

CODE NO. E-38

Above materials to exist lot #15 used to produce unit 25-1002, using 6/2A in a 0.5" times 200 mesh (ASTM B-71A)

Total danger sum (para 2.3.2) = .22 .55 (for elements listed at less than the detection limit, REMARKS the detection limit has been used for calculating the total danger sum)

Two (2) 50 gram chip samples for customer part # 2.1/1.22 are appended to this report

KAWECKI BERYLCO INDUSTRIES, INC.
P.O. BOX 429, HAZLETON, PA. 18201

7/8/78
E.G & G
D. J. Schubert
By Edward A. Rash
E. H. RASH

Title Q. C. SURVEYOR

KAWECKI BERYLCO INDUSTRIES, INC.

 KBI

P.O. Box 429, Hazleton, Pa. 18201
Telephone: 717 / 455-4913

Date June 20, 1972

Mech Spec. P.O. # S51668
KRI P.O. # 58-4359
Dvg # 403228-1, Rev B
Material Specification ANC-600050
ATR Beryllium Reflector Material Blank
Pressing # 651A E. G. & G. S/N 023
651A 023

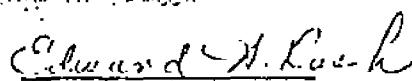
Reviewed
JF

Certification Contents

1. Chemical Composition
2. Mechanical Properties
3. Mechanical Properties Stress Strain Charts
4. Physical Properties - Density etc.
5. Radiographic Report
6. Dimensional Report
7. Liquid Penetrant Report
8. Certification of Material Compliance
9. In-Process Routing of Segment
10. In-Process Routing of Mechanical Test Specimens
11. In-Process operational sketches
12. Beryllium Powder Release

Remarks:

One Copy of S.R.D.A. 0138 enclosed and copy of sketch


Edward H. Lash
KRI Q. C. Supervisor

M. S. C. MATERIAL
METALS • ALLOYS • CHEMICALS
CODE NO. E-37

CUSTOMER:		KAWECKI BERYLCO INDUSTRIES, INC.			DATE:	
Mechanical Sales Co. CUSTOMER LOCATION Los Angeles, Ca. CUSTOMER P. O. NUMBER Tech. Spec. P.O. 551668 E.C. A.G. P.O. K2557		POST OFFICE BOX 429 HAZLETON, PENNSYLVANIA 18201			APR-12, 1978 BERYLCO ORDER NO. ER-1-240 SPEC NUMBERS	
QUALITY CONTROL MATERIAL TEST REPORT						AMC-80005 F

DESCRIPTION: One (1) Blank Per AMC Drawing 10322A Rev. B

K.R.T. Unit No. 25-1003, Hot Pressing No. 651A

E.C. A.G. S/N 023

NUMBER	A51A	Pb	A51A	Pb	A51A
Be Assay	02.21	Pb	0.0001	In	<0.0001
BeO	2.00	Si	<0.0001	Sc	<0.0001
C	0.065	Mo	<0.0010		
Fe	0.1590	Ti	0.0070		
Al	0.0120	B	0.0001		
Mg	0.0055	Gd	<0.0001		
Sr Ym	0.0040	Li	<0.0001		
Hg	0.0225	F	0.0070		
Cr	0.0050	Cl	<0.0050		
Ca	< 0.0200	Br	0.0054		
Co	0.0021	I	<0.0001		
Cr	0.0120	In	<0.0001		
Zn	< 0.0001	Ge	<0.0001		
As	< 0.0001	Fr	<0.0001		
U.T.S.		NH	<0.0001		
.2% Y.S.		Sm	<0.00005		
% El.		Ta	<0.00005		
		Gd	<0.00005		
		Th	<0.0001		
		Br	<0.00002		
		In	<0.0001		
		Fr	<0.00005		
		Tm	<0.00005		
		Yb	<0.00002		
DENSITY					
T- Count	3,550	$\times 10^{-3}$			

Since analysis of powder lot 5503 used to produce unit 25-1002, powder A51A = 0.0001
minus 200 mesh (ASTM R-214).

Total danger sum (Par. 1,2,2) = 21.10 (For elements listed at less than the detection limit,
the detection limit has been used for calculating the total danger sum).

REMARKS

Two (2) 50 cm² samples for customer per Par. 1,2,1/b,2,2 are forwarded to this report.

EG & G
 J.C. Frizelle
 1/13/78
 By J.C. Frizelle
 Title: J.C. Frizelle
 M.S.C. Foreman

M. S. C. MATERIAL
 CODE NO. E-37

MOC-PA

KAWECKI BERYLCO INDUSTRIES, INC.



P. O. Box 429, Hazleton, Pa. 18201
Telephone: 717 / 455-4913

Date August 30, 1978

Mech Spec. P.O. # 551668
KBI P.O. # 58-4359
Dwg # 403228-1 Rev B
Material Specification ANC-800050
AT&T Beryllium Reflector Material Blank
Pressing # 679A E. G. & G. S/N 024

Reviewed
JF

Certification Contents

1. Chemical Composition
 2. Mechanical Properties
 3. Mechanical Properties Stress Strain Charts
 4. Physical Properties - Density etc.
 5. Radiographic Report
 6. Dimensional Report
 7. Liquid Penetrant Report
 8. Certification of Material Compliance
 9. In-Process Routing of Segment
 10. In-Process Routing of Mechanical Test Specimens
 11. In-Process operational sketches
 12. Beryllium Powder Balance
- Remarks:

M. S. C. MATERIAL
CODE NO. E-36

Edward H. Kish
Edward H. Kish
KBI Q. C. Supervisor

METALS - ALLOYS - CHEMICALS

CUSTOMER Mechanical Spec. Co.	KAWECKI BERYLCO INDUSTRIES, INC. POST OFFICE BOX 429 HAZLETON, PENNSYLVANIA 18201	DATE 8/30/78
CUSTOMER LOCATION Los Angeles, Calif.		BERYLCO ORDER NO. 58-4359
CUSTOMER P. O. NUMBER Mech. Spec. P.O. 851668 E. G. & G. P.O. K2557	QUALITY CONTROL MATERIAL TEST REPORT	SPEC. NUMBERS ANC - 80005F

DESCRIPTION
one (1) Blank per ANC Drawing 403228-1 Rev B (HA 5470)

K.B.I. Unit 25-1004, Hot Pressing No. 679A

E. G. & G. S/N 024

NUMBER	679A	Element	679A	Element	679A
Be Assay	98.33	Pb	0.0001	Lu	<0.00005
BeO	2.00	Si	0.0340	Sc	0.00022
C	0.077	Mo	<0.0010		
Fe	0.1500	Ti	0.0070		
Al	0.0350	R	0.00020		
Mg	0.0055	Cd	<0.0001		
EX Mn	0.0060	Li	<0.0001		
Ni	0.0225	F	0.0070		
Cr	0.0095	Cl	<0.0050		
Ca	<0.0200	Ba	0.0072		
Co	0.0014	I	<0.0010		
Cu	0.0090	La	<0.0001		
Zn	<0.0100	Ce	<0.0001		
Ag	<0.0001	Pt	<0.0001		
U.T.S.		Nd	<0.0005		
.2% Y.S.		Sm	<0.00005		
% El.		Eu	<0.00005		
		Gd	<0.00002		
		Th	<0.0001		
		Dy	<0.00002	M. S. C. MATERIAL	
		Ho	<0.00001	CODE NO.	E-34
		Er	<0.00005		
		Tm	<0.00005		
DENSITY		Tb	<0.00002		

T-Count 2.455×10^{-6}

Sieve analysis of Powder Lot 5547 used to produce unit 25-1004. Pressing 679A was 99.9% minus 200 mesh (ASTM B-214)

TOTAL Danger Sum (Para 3.3.2) = 35.81 (For elements listed at less than the detection limit, the detection limit has been used for calculating the total danger sum)

Two (2) 50 gram samples for customer per Para. 4.2.1/4.2.2. are appended to this report.

KAWECKI BERYLCO INDUSTRIES, INC.
P.O. BOX 429, HAZLETON, PA. 18201

9-6-78

By

Edward H. Pash
Edward H. Pash

Title

Q.C. Supervisor

KAWECKI BERYLCO INDUSTRIES, INC.



P. O. Box 429, Hazleton, Pa. 18201
Telephone: 717 / 455-4913

Date October 31, 1978

Mech Spec. P.O. # S51668
KBI P.O. # 58-4359
Dwg # 403228-1 Rev B
Material Specification ANC-800050
ATR Beryllium Reflector Material Blank
Pressing # 710A E. G. & G. S/N 026

Received
E

Certification Contents

1. Chemical Composition
2. Mechanical Properties
3. Mechanical Properties Stress Strain Charts
4. Physical Properties - Density etc.
5. Radiographic Report
6. Dimensional Report
7. Liquid Penetrant Report
8. Certification of Material Compliance
9. In-Process Routing of Segment
10. In-Process Routing of Mechanical Test Specimens
11. In-Process operational sketches
12. Beryllium Factor Release

Remarks:

Edward H. Rash
Edward H. Rash
KBI Q. C. Supervisor

METALS • ALLOYS • CHEMICALS

CUSTOMER Mechanical Spec. Co.		KAWECKI BERYLCO INDUSTRIES, INC.	
CUSTOMER LOCATION Los Angeles, Calif.		POST OFFICE BOX 429 HAZLETON, PENNSYLVANIA 18201	
STOKER P. O. NUMBER Tech. Spec. P.O. S51668 E.G.&G. P.O. K2557		DATE October 30, 1970	
		SERIAL ORDER NO. 58-4359	
		SPEC. NUMBERS ANC-80005 F	
QUALITY CONTROL MATERIAL TEST REPORT			
DESCRIPTION One (1) Blank Per ANC Dwg. 403228 Rev. B			
K.B.I. UNIT No. 25-1007		Hot pressing No. 710A	
E.G. & G. S/Ns. 026			
NUMBER		710A	710A
Be Assay		98.25	Pb <0.0001
BeO		2.0	Si 0.0315
C		0.107	Mo <0.0010
Fe		0.156%	Ti 0.0015
Al		0.034%	B 0.00028
Mg		0.004%	Cd <0.0001
Ni		0.029%	Li <0.0001
Mn		0.005%	F 0.0080
Cr		0.0100	Cl <0.0050
Ca		< 0.0200	
Co		0.0009	
Cu		0.0090	
Zn		< 0.0100	
Ag		0.0002	
U.T.S.			
.2% Y.S.			
% El.			
DENSITY		1.856 g/cc	
T-Count		6720 x 10 ⁻⁶	
Sieve analysis of powder Lot 5625 used to produce unit 25-1007. Pressing 710A was 99.9 % minus 200 mesh (ASTM B-214).			
Total danger sum (Para. 3.3.2) - 34.19 (for elements listed at less than the detection limit). The detection limit has been used for calculating the total danger sum.			
Two(2) 50 Grams Samples for customer per Para. 4.2.1/4.2.2 are appended to the report.			
By J.A. Dzulba 10-31-78 J.A. Dzulba			

KAWECKI BERYLCO INDUSTRIES, INC.
P.O. BOX 429 HAZLETON, PA. 18201

By *J. H. Dzuiba*
Title *O. C. Forman*

KAWECKI BERYLCO INDUSTRIES, INC.



P. O. Box 429, Hazleton, Pa. 18201
Telephone: 717 / 455-4013

Date February 20, 1979

Spec. P.O. # 551668
KBI P.O. # 58-4359
Dwg # 403228-1 Rev B
Material Specification ANC-300096
APR Beryllium Reflector Material Blank
Pressing # 761A E. G. & G. S/N 028

Reviewed

Certification Contents

1. Chemical Composition
2. Mechanical Properties
3. Mechanical Properties Stress Strain Charts
4. Physical Properties - Density etc.
5. Radiographic Report
6. Dimensional Report
7. Liquid Penetrant Report
8. Certification of Material Compliance
9. In-Process Routing of Segment
10. In-Process Routing of Mechanical Test Specimens
11. In-Process operational sketches
12. Beryllium Powder Release

Remarks:

Edward H. Lash
Edward H. Lash
KBI D. C. Supervisor

METALS • ALLOYS • CHEMICALS

CUSTOMER Mechanical Specialty Co.	KAWECKI BERYLCO INDUSTRIES, INC.		DATE April 23, 1979
CUSTOMER LOCATION Los Angeles, California	POST OFFICE BOX 429 HAZLETON, PENNSYLVANIA 18201		REF ID 58-4359
CUSTOMER P. O. NUMBER S51668	QUALITY CONTROL MATERIAL TEST REPORT		SPC NUMBERS ANS-8000SF

DESCRIPTION
One (1) Blank per ANC Drawing 403228 Rev. B

K.B.I. Unit No. 25-1010, Hot Pressing No. 761A E646 SN 028

NUMBER	761A	Element 761A	Element 761A
Be Assay	98.35	Pb < 0.0001	Lu < 0.00005
BeO	1.98	Si 0.0310	Sc 0.0003
C	0.063	Mo < 0.0010	
Fe	0.1350	Tl 0.0055	
Al	0.0100	B 0.0002	
Mg	0.0060	Cd < 0.0001	
Ni	0.0200	Li < 0.0001	
Mn	0.0070	F 0.0055	
Cr	0.0105	Cl < 0.0050	
Ca	< 0.0200	Br 0.0061	
Co	< 0.0010	I < 0.0010	
Cu	0.0070	La < 0.0001	
Zn	< 0.0100	Ce < 0.0001	
Ag	0.0001	Pr < 0.0001	
U.T.S.		Nd < 0.0035	
.2% Y.S.		Sm < 0.00005	
% El.		Eu < 0.00005	
		Gd < 0.00002	
		Tb < 0.0001	
		Dy < 0.00002	
		Ho < 0.0001	
		Er < 0.00005	
		Tm < 0.00005	
DENSITY		Yb < 0.00002	

T-Count - 2.1900×10^{-6}

Sieve analysis of Powder Lot 5722 used to produce unit 25-1010. Pressing 761A was 99.9 % minus 200 mesh (ASTM B-214)

Total Danger Sum (Para. 3.3.2) = 35.28 (For elements listed at less than the detection limit, the detection limit has been used for calculating the total danger sum)

REMARKS

Two (2) 50 gram samples for customer per Para. 4.2.1/4.2.2 are appended to this report.

KAWECKI BERYLCO INDUSTRIES, INC.
P.O. BOX 429, HAZLETON, PA. 18201

OK. D.W. Smith
EC & G QE 5/8/79

By

Title

J. A. Dubba
Q. C. Foreman

Mechanical Spec. Co.	KAWECKI BERYLCO INDUSTRIES, INC.	DATE
CUSTOMER LOCATION	POST OFFICE BOX 429	February 20, 1979
Los Angeles, California	HAZLETON, PENNSYLVANIA 18201	EXCITO-SPEC NO.
CUSTOMER P. O. NUMBER		58-4359
tech. Spec. Co.	QUALITY CONTROL MATERIAL TEST REPORT	SPC NUMBERS
S51668		ANC-80005G
E.G.&G. P.O. K2557		
DESCRIPTION		

One (1) Blank per ANC Drawing 403226-1 Rev. B (HA-5170)

K.B.I. Unit No. 25-1010 Hot Pressing No. 761A S/N 028

NUMBER	761A	761A
Se Assay	98.35	Pb < 0.0001
SeO	1.98	Si 10.0240
C	0.693	Mg < 0.0010
Fe	0.1380	Ti 0.0055
Al	0.0100	B 0.0002
Mg	0.0060	Cd < 0.0001
Ex Ni	0.0200	Li < 0.0001
Ma	0.0070	F 0.0055
Cr	0.0105	Cl < 0.0050
Ca	< 0.0200	
Co	0.0010	
Cu	0.0070	
Zn	< 0.0100	
Ag	0.0001	
U.T.S.		
.2% Y.S.		
% EI.		
DENSITY		

T-Count 2.19×10^{-5}

Sieve Analysis of Powder Lot 5722 used to produce unit 25-1010. Pressing 761A was 99.9% minus 200 mesh (ASTM E-214)

REMARKS Two (2) 50 gram chip samples for customer per Para. I.2.1/I.2.2 are appended to the report.

NOTE: The T.D.A. will be completed and submitted on corrected certification upon receipt of additional analysis report from vendor laboratory. Final acceptance of material will be based upon acceptance of these values.

KAWECKI BERYLCO INDUSTRIES, INC.
P.O. BOX 429, HAZLETON, PA. 18201

By Edward H. Fisch
Edward H. Fisch
Title Q. C. Supervisor

2-3-79
HOC-1A

Appendix B

Analytical Test Data from Argonne National Laboratory-West on the Advanced Test Reactor Beryllium Samples

Appendix B

Analytical Test Data from Argonne National Laboratory-West on the Advanced Test Reactor Beryllium Samples

Appendix B contains reproduced reports from Argonne National Laboratory-West on their measurements of various constituents of samples taken from the beryllium reflector blocks currently in the Advanced Test Reactor canal.

ARGONNE NATIONAL LABORATORY-WEST

P.O. Box 2528, Idaho Falls Idaho 83403-2528

Telephone: (208) 533-7318

NT-AL-(JRK)-01-090

November 7, 2001

Randy Rice
BBWI,LLC, WGS
Central Facilities Area 615
MS 4110
P.O.Box 1625
Idaho Falls, Idaho 83415-4110

Reference: WGS-047-01 Sampling and Analysis Plan for the Transuranic Content from the High Neutron Flux Region of ATR Beryllium Block SN-010R

Dear Mr. Rice,

Two beryllium samples described in the reference document have been analyzed for uranium, transuranic isotopes, fission product Cs-137, activated Co-60, and stable Hg isotopes. The results are given in Table I. Samples were assigned an Analytical Laboratory number. This number is shown in row 1. The information given in the second row is your sample identification information. The analytical number identifies the sample in our database. The Table I data provides a cross-reference between the INEEL identification number and our database.

Analyses. The activity of these samples required the initial analytical work to be performed remotely in a shielded facility where contamination is a concern. Any surface contamination was removed by etching with hydrofluoric acid. 2.3410 grams of beryllium were dissolved in a mixture of 2 M HF and 9M HCl. The dissolved samples were then treated with boric acid and EDTA to ensure complete dissolution and to prevent loss of actinides by precipitation as a fluoride. The standard and "blind" were dissolved using a procedure developed for all other beryllium samples previously analyzed.

Inductively coupled plasma-mass spectroscopy (ICP-MS) and radiochemical measurements were made on both the original dissolver solutions and on separated fractions. Separations were required to remove activity, isobaric interference, and provide alpha energy discrimination. Separations were performed after aliquots of the original dissolver solutions were converted to the appropriate acid matrix. The prepared aliquots were loaded onto resin columns. The actinides were eluted selectively. Selectivity is accomplished by changing the molarity and composition of the eluant. Am and Cm were first eluted using 10 M HCl. Pu was eluted with 10 M HCl/0.1 M HI, and Np was eluted with 4M HCl. Uranium was eluted last with a 0.1 M HCl solution.

The results reported for Pu-238 were calculated from radiochemical data. The results for the rest of the radionuclides reported in Table I were calculated from ICP-MS data. Results for several radionuclides calculated from radiochemical data are reported here for your information (Pu-239/240 = 0.78 $\mu\text{g/g}$, Pu-242 = 0.27 $\mu\text{g/g}$, Am-241 = 0.07 $\mu\text{g/g}$, Am-243 = 0.32 $\mu\text{g/g}$, and Cm-244/243 = 0.29 $\mu\text{g/g}$). Np-237 was not detected by either ICP-MS or counting.

Quality Assurance. NIST traceable standards were used where available. Other standards were prepared at ANL-W and standardized using standard radiochemical techniques. The standards used for this effort are listed below:

Uranium	High Purity Standards Catalog Number ICP-MS-KIT-A
Plutonium	CRM-126
Neptunium	ANL-W Prepared standard
Americium	ANL-W Prepared Standard
Curium	Isotopes Product Laboratory Source Number 678-14
Mercury	High Purity Standards Catalog Number ICP-MS-KIT-C

The ICP-MS was calibrated for curium using Am-243. The ionization potentials for all of the measured actinides are within 1.3 % and the calibration slopes were essentially identical.

Control standards, calibrated detectors, and reviewed and approved procedures were used to ensure radiochemical quality control

If you have any questions, please feel free to call me at 208-533-7318.

Sincerely,

John Krsul
Manager, Analytical Laboratory

JRK:bb

Att.
Final Reports

pc:
Steve Aumeier
Charles D. Brooks, MS 7106
Michael L. Carboneau, MS 3885
Teresa Carlson
Michael J. Connolly, MS 3710
Jeff Giglio
Donna F. Haney, MS 4110
Steve Johnson
Carlan K. Mullen, MS 4142
Marianne Noy
Doug Porter

Table I. Results of Uranium, Transuranium, Fission Cesium-137, and Co-60 Measurements in Irradiated Beryllium.

Nuclide	Unit	82589 99A162	82590 Blind	82553A SN-010R W04701011TR	82553B SN-010R W04701012TR	Average ($\mu\text{g/g}$)	Average (nCi/g)
Tot U	$\mu\text{g/g}$	73	51				
U-235	$\mu\text{g/g}$	0.72 w/o	0.69 w/o	<.03	<.01		
U-238	$\mu\text{g/g}$	99.27w/o	99.31w/o	11.1	9.5	10.3	
Np-237	$\mu\text{g/g}$						
Tot Pu							
Pu-238	$\mu\text{g/g}$			0.002	0.002	0.002	34.3 Counting
Pu-239	$\mu\text{g/g}$			0.25	0.23	0.24	14.9 ICP-MS
Pu-240	$\mu\text{g/g}$			0.25	0.21	0.23	52.2 ICP-MS
Pu-241	$\mu\text{g/g}$			0.02	0.02	0.02	ICP-MS
Pu-242	$\mu\text{g/g}$			0.16	0.14	0.15	0.6 ICP-MS
Am-241	$\mu\text{g/g}$			0.07	0.07	0.07	241 ICP-MS
Am-242	$\mu\text{g/g}$						
Am-243	$\mu\text{g/g}$			0.21	0.20	0.205	41 ICP-MS
Cm-244	$\mu\text{g/g}$			0.38	0.38	0.38	ICP-MS
Cm-245	$\mu\text{g/g}$			0.03	0.03	0.03	5.2 ICP-MS
Cm-246	$\mu\text{g/g}$			0.15	0.15	0.15	45.6 ICP-MS
Cm-247	$\mu\text{g/g}$			0.007	0.007	0.007	0.0006 ICP-MS
Tot TRU						435	
Cs-137	$\mu\text{Ci/g}$			49	51	50 $\mu\text{Ci/g}$	
Co-60	$\mu\text{Ci/g}$			375	375	375 $\mu\text{Ci/g}$	
Hg 198	$\mu\text{g/g}$			0.025	0.025	0.025	
Hg 199	$\mu\text{g/g}$			0.03	0.03	0.03	
Hg 200	$\mu\text{g/g}$			0.15	0.17	0.16	
Hg 201	$\mu\text{g/g}$			<.017	<.017	<.017	
Hg 202	$\mu\text{g/g}$			<.015	<.015	<.015	
Hg 204	$\mu\text{g/g}$			<.015	<.015	<.015	
Hg, Min	$\mu\text{g/g}$			0.205	0.225	0.215	
Hg, Max	$\mu\text{g/g}$			0.252	0.272	0.262	

ARGONNE NATIONAL LABORATORY-WEST

P.O. Box 2528, Idaho Falls Idaho 83403-2528

Telephone: (208) 533-7318

NT-AL-(JRK)-01-029
April 9, 2001

Charles D. Brooks
BBWI
MS 7106
Idaho Falls, Idaho 83415-3860

Dear Mr. Brooks,

Reference: Modification No. 2 to Inter-Contractor Purchase No. F00-564335 Bechtel BWXT Idaho, LLC

Eight beryllium samples and a standard have been analyzed for uranium, niobium and plutonium. The results of the analyses are given in Table I.

Table I. Uranium, Niobium, and Plutonium results.

Analytical Number.	Sample ID	Sample Description	Sample Wt. (g)	ICP-MS Nb-93 ($\mu\text{g/g}$)	ICP-MS Uranium ($\mu\text{g/g}$)	U-235 U-238 Ratio	ICP-MS Pu-239 (ng/g)	Fluorimetry Uranium ($\mu\text{g/g}$)
79778	W03699051INC	SN-010R	0.1550	1	30	.0053	70	37
79779	W03699061INC	SN-015R	1.1513	16	32	.0053	45	27
79780	W03699071INC	SN-016L	NA	NA	NA	NA	NA	NA
79781	W03699081INC	SN-016R	0.9662	23	24	.0053	51	31
79782	W03699091INC	SN-017L	NA	NA	NA	NA	NA	NA
79783	W03699101INC	SN-017R	0.0571	18	24	.0056	ND	NA
79784	W03699111INC	SN-018R	0.3004	21	25	.0056	59	28
79785	W03699121INC	SN-020L	0.1773	13	25	.0054	52	32
79786	W03699131INC	SN-021L	0.3522	11	27	.0053	70	26
79787	W03699141INC	SN-022L	NA	NA	NA	NA	NA	NA
79788	W03699151INC	SN-11R	NA	NA	NA	NA	NA	NA
79789	W03699161INC	SN-15L	0.0432	2	41	.0070	ND	NA
Standard	S200F	U (65 $\mu\text{g/g}$)	0.3620	0.6	57	.0073	ND	55

NA = Not Analyzed

ND = Not Detected

Uranium was measured using fluorimetry and ICP-MS. The results for each method are given in Table I for comparison purposes. Samples 79783 and 79789 were not analyzed for uranium using fluorescence because of the small mass available, 0.051 and 0.0432 grams, respectively. The amount of uranium available may have been too low for the sensitivity of this method. ICP-MS was used to collect

information to determine and calculate niobium and plutonium data. The estimated errors for these measurements are: uranium by ICP-MS = \pm 10%, niobium for all analyses except #79778 & 79789 \pm 10%, niobium (79778 & 79789) = \pm 25% and plutonium = \pm 25%. A brief description of each method is given below for information purposes.

Uranium analysis by fluorimetry involves the excitation of electrons in uranium to a higher energy state using ultraviolet radiation. After excitation, the electrons always return to their ground state energy. During this process, the excess energy is released as photons (green light in the visible spectrum at a wavelength of 550 nm). The relaxation process by which this occurs is called "fluorescence". The spectral wavelengths of the fluorescent radiation are always longer than the wavelengths of the excitation source.

The fluorimeter consists of a sample excitation source (UV source with peak radiation at 355 nm). Once the excited sample has released its excess energy, the energy passes through a filter system before arriving at the detector. The detector is a photomultiplier tube. This then converts the radiant energy into an electrical signal. The signal is displayed on a digital readout. Prior to any analysis, the fluorimeter must be calibrated with a standard of known uranium composition. The signal in the standard is relative to the quantity of uranium present. Blanks and spiked samples are run with each analysis.

Uranium, plutonium and niobium were measured using ICP-MS. The technique of quadrupole-based ICP-MS employs radio frequency plasma generated in pure argon gas. Plasma temperatures are typically in the range of 5000 to 8000 degrees Celsius. The plasma is generated in a quartz tube or torch. The torch is designed to aspirate an aerosol of sample into the central region of the plasma, where the sample and solvent atoms and molecules are atomized and ionized to varying degrees, depending on the plasma temperature and the ionization energy of the particular element. For example, most transition metal atoms are 85 to 99% ionized. The plasma is drawn into the mass spectrometer section through a water-cooled nickel cone with a 1 mm sampling orifice, and on through a number of differentially pumped vacuum chambers. Differential pumping allows an atmospheric pressure sample introduction to a high-vacuum region through a series of turbopumped chambers connected by small (on the order of 1mm) orifices; the pressure in each chamber lowers as you progress toward the high vacuum region where the mass analyzer resides. Electrically charged cylindrical "lenses" serve to first accelerate and then focus the ionized atom "beam" through these orifices and into the entrance of a quadrupole mass spectrometer.

The quadrupole acts as a mass filter with a resolution of ~1 atomic mass unit. This means, that while a quadrupole can separate Mg-24 from Mg-25, it cannot resolve Cr-50 from Ti-50. When such same-mass, or isobaric interference occurs, correction schemes must be applied by using other isotopes of a particular elemental species to determine the contribution of that element to the overall signal at the given mass. The quadrupole allows only one mass at a time through to the detector, where the signal at that mass is determined in counts per second. This count rate is used along with the calibration curve to quantitate the mass. Note that prior separation of two elements is not necessary when their isotopes are at different masses.

The calibration of the ICP-MS is typically external, using 3 to 4 elemental standards of known concentration to generate a calibration curve. A non-interfering internal standard such as In-115

or Rh-103 is used to normalize the count rates in samples and standards to correct for possible instrumental response "drift" during an analytical run. ICP-MS is well known for its sensitivity for metals, which can range from ug/L to pg/L in solution; in addition, the calibration curves are usually linear over 5 to 7 orders of magnitude.

Since quadrupole ICP-MS separates the ions according to mass for quantitation, niobium, at mass 93 (and a radioisotope Nb-94) does not need prior separation from tantalum, at masses 180 and 181. This is one of the great advantages of atomic mass spectrometry.

Samples of beryllium were dissolved in a mixture of HCL and HF. The resulting dissolver solution was brought to a known volume. Aliquots of each dissolver solution were treated chemically and diluted for each instrumental method of analysis.

All remaining solid beryllium samples have been consumed. A limited amount of dissolver solution (approximately 40 mls) of each sample listed above is available for additional work. These samples will be disposed in 30 days unless additional work is requested.

If you have any questions, please feel free to call me at (208) 533-7318 or Jeff Berg at (208) 533-7276.

Sincerely,

John Krsul, Manager
Analytical Laboratory

Att.
Final Reports

pc: J. Berg
 M. Carboneau MS 3885
 T. Carlson
 D. Crawford
 D. Cummings
 S. Johnson
 C. Mullen MS 4142
 J. Sterbentz MS 3885

ARGONNE NATIONAL LABORATORY-WEST

P.O. Box 2528, Idaho Falls Idaho 83403-2528

Telephone: (208) 533-7318

July 10, 2000

Roger Piscitella
BBWI
P.O. Box 3860
MS 4142
Idaho Falls, Idaho 83415-3860

Reference: WGS-036-99 Abbreviated Sampling and Analysis Plan for TRA ATR Beryllium Blocks Supports-Phase IA of the ATR Comprehensive Beryllium Disposition Plan.

Dear Mr. Piscitella

Twelve beryllium samples described in the reference document have been analyzed. The results are given Table I. Samples were assigned an Analytical Laboratory number. This number is shown in column 1. The information given in the second column is your sample identification information. The analytical number identifies the sample in our database. The Table provides a cross-reference between your identification number and our database.

Table I. Samples Analysis Results.

Analytical Number	Sample ID	Sample Description	Density (g/cc)	C-14 ($\mu\text{Ci/g}$)	Co-60 ($\mu\text{Ci/g}$)	Cs-137 ($\mu\text{Ci/g}$)	Nitrogen (ppm)	Carbon (ppm)	Activity (mr/hr/g)
79778	W03699051NC	SN-010R	1.851	0.61	13.1	0.2	203	734	32
79779	W03699061NC	SN-015R	1.852	0.24	25.4	0.1	178	637	49
79780	W03699071NC	SN-016L	1.862	0.58	17.6	0.2	208	824	40
79781	W03699081NC	SN-016R	1.854	0.35	52.5	0.1	181	804	41
79782	W03699091NC	SN-017L	1.853	0.18	15.7	0.1	152	693	48
79783	W03699101NC	SN-017R	1.853	0.41	74.1	0.1	224	681	85
79784	W03699111NC	SN-018R	1.854	0.36	46.0	0.2	160	650	136
79785	W03699121NC	SN-020L	1.856	0.52	47.4	0.2	253	1099	84
79786	W03699131NC	SN-021L	1.853	0.51	46.4	0.3	287	678	98
79787	W03699141NC	SN-022L	1.857	0.29	26.2	0.1	252	715	73
79788	W03699151NC	SN-11R	1.861	0.33	2.41	0.1	186	665	5
79789	W03699161NC	SN-15L	1.851	0.35	2.44	0.1	181	761	3

Table II gives the results of the analysis of two standards and two unknowns submitted with the 12 samples.

Table II. Results of the Analysis of Standards

Sample ID	Description	No.	Nitrogen (ppm)	Sample ID	Description	No.	Nitrogen (ppm)
W03699011N2	99-A-163	1	357	W03699031N2	S200F (99-A-162)	1	218
		2	359			2	214
		3	363			3	223
	Average		359		Average		218
	SD		3		SD		±5
W03699021N2	99-A-156	1	200	W03699041N2	S65C (99-A-157)	1	73
		2	198			2	85
		3	206			3	64
	Average		201		Average		74
	SD		2		SD		±10

W03699011N2 is a LECO steel pin standard (359 ± 7 ppm). W03699021N2 is a beryllium metal nitrogen standard (202 ± 12 ppm nitrogen). W03699031N2 and W03699041N2 are beryllium chips. The nitrogen concentrations were not given in the reference document, but were later identified as 548 ppm and 58 ppm, respectively.

Sample Preparation. The samples, received with Chain-of-Custody, were packaged in 250-ml polybottles filled with water. The samples were stored as received until analysis. Visual observations of the samples showed that some containers contained a single sample and others contained several pieces. The activity of each sample was estimated with a portable survey meter. The samples were prepared for analysis using the following procedure. Water was drained from each container to retrieve the samples. While the samples were still wet, a wet weight was obtained. The samples were dried, weighed and then weighed after a period of time to a constant weight. The dry weights and the wet weights were used to calculate the densities. Beryllium was sized for various analyses by breaking the samples with a center punch, chisel, and a hammer. This step was performed using a stainless steel beaker fitted with a lid. The lid had a hole for access to the center punch or chisel. Using this technique, the irradiated ATR beryllium was easily sized providing material for carbon-14, nitrogen, and gamma analyses.

Carbon-14 Analysis. Radioactive samples are routinely analyzed for total carbon using a remote furnace LECO HF-400/IR-412 carbon analyzer. The sample is placed in a ceramic crucible along with an accelerator to provide coupling for the induction furnace heating in an oxygen environment. Sample combustion releases all sample carbon in the form of CO and CO₂, which is quantitatively converted to CO₂ by passage through a hot rare earth-copper oxide (350°C) reagent tube. Total carbon is measured by CO₂ IR absorption. The CO₂ is then trapped in a removable solid sorbent CO₂ trap. The trap is removed from the system and purged to remove all carbon dioxide, which is trapped by bubbling through an amine solution. The solution is mixed with a compatible liquid scintillation cocktail and counted for C-14 beta activity.

Table III gives the results for the repeated measurement of known C-14 activity deposited on stainless steel using this method.

Table III. Results of C-14 Standard Assay.

Standard ID	Date	C-14 Activity	Recovered Activity	% Recovery
1	9/3/99	22644	23028	102
2	9/8/99	22644	22374	98.8
3	9/9/99	22644	21057	93.0
4	9/13/99	22644	22341	98.7

For the ATR beryllium, samples of beryllium were sectioned from the bulk material, weighed, and placed into polybottles. The samples were transferred into the Analytical Laboratory Hot Cells, and submitted to the analyzer to release and collect the carbon as CO₂. The separated radiocarbon was counted with a Packard Tri-Carb 2700 TR liquid scintillation analyzer. The error, $\pm 7.5\%$ 1-sigma, given for the carbon data is estimated from the repeated measurement of radiocarbon standards, percent recoveries, and overall process errors associated with hot cell operations.

Nitrogen Analysis. The remote furnace LECO EF-400/TC-436 nitrogen/oxygen analyzer is used to determine total oxygen and nitrogen content and nitride/oxide concentrations of irradiated reactor hardware and unirradiated and conditioned metallic spent fuel. The sample is placed in a graphite crucible in the furnace. Sample fusion releases oxygen and nitrogen in a helium atmosphere. Helium carrier gas transfers the released nitrogen and oxygen through a thermal conductivity cell and IR cell, respectively, to measure the amount of each gas released. A determination begins by placing an empty graphite crucible between the two electrodes in the furnace. The crucible is sealed and purged of all atmospheric gases. High current is then passed through the crucible; high heat is generated which drives off gases trapped in the graphite (called outgassing). Next, a sample is dropped from the loading mechanism into the crucible. High current is again passed through the crucible driving off gases in the sample. To prevent further outgassing during analysis, a lower current is used during analysis to drive off sample gases. The oxygen released from the sample combines with the carbon from the crucible to form carbon monoxide. The sample gases pass through heated rare earth copper oxide which converts the carbon monoxide to carbon dioxide. The sample gases are then passed through the IR cell which detects the oxygen as carbon dioxide. After detection, carbon dioxide is removed with Lecosorb® to prevent detection by the TC cell. Water is formed when the carbon dioxide is trapped and the water vapor, which would also be detected by the TC cell, is removed with Anhydrene™. Gas flow passes through the thermal conductivity cell which detects nitrogen.

Considerable development work was required to develop a technique to prepare samples of beryllium for nitrogen determination. For these analyses small pieces of beryllium and nickel flux were weighed and placed in a nickel capsule. The capsule was formed into a pellet using a press. Duplicates were prepared for each sample. Multiple samples were prepared for the standards and unknowns. The measuring of nitrogen in irradiated beryllium proved to be difficult, shown by the precision obtained for duplicate measurements. There are a number of variables that may effect the precision. These variable include the small sample size, pellet forming difficulties, uncertainty resulting from the loading of the pellet into the analyzer, and the operation of the analyzer itself. The overall error for these measurements is estimated to be ± 21 ppm at 1- sigma. Samples 79781, 79786 and 79789 are

exceptions, with an estimated error of ± 3 ppm. The precision is essentially the largest part of the uncertainty for these measurements. The analyzer was calibrated using LECO 501-645 Steel Pin NO Standard. The certified standard concentration is 265 ± 7 ppm nitrogen.

Gamma Analysis of Dissolved ATR Beryllium. Weighed samples of beryllium were dissolved in hydrofluoric acid, hydrochloric acid and hydrogen peroxide. The resulting dissolver solution was brought to volume with IX water. For gamma analysis of dissolved ATR beryllium, the dissolved sample was made up in a 50-ml vial for gamma spectrometry, typically containing 50 to 200 mg of the original beryllium. The resulting spectra were subsequently subjected to gamma-ray analysis. The gamma-ray spectra were mostly composed of Co-60. Due to the predominance and high gamma-ray energy of Co-60, most other gamma-ray emitters were hidden in the Compton plateau of the spectrum. The only observed gamma-ray emitter, other than the Co-60, was Cs-137.

Density Measurement. Density measurements were made using a procedure based on Archimedes' principle in determining sample volume. The estimated error for the density measurement is 0.005%.

If you have any questions, please feel free to call me at (208) 533-7318 or Jeff Berg at (208) 533-7276.

Sincerely,

John Krsul, Manager
Analytical Laboratory

Att.
Final Reports

pc: Jeff Berg
Charlie Brooks
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NT-AL-(JRK)-01-012
February 2, 2001

K. Jean Holdren
BBWI
P.O. Box 3860
MS 3920
Idaho Falls, Idaho 83415-3860

Reference: WGS-036-99 Abbreviated Sampling and Analysis Plan for TRA ATR Beryllium Blocks Supports-Phase IA of the ATR Comprehensive Beryllium Disposition Plan.

Dear Ms. Holdren,

Two beryllium samples described in the reference document have been analyzed for niobium. The results are given Table I. Samples were assigned an Analytical Laboratory number. This number is shown in column 1. The information given in the second column is your sample identification information. The analytical number identifies the sample in our database. The Table provides a cross-reference between your identification number and our database.

Table I. Samples Analysis Results

<u>Analytical No.</u>	<u>Sample ID</u>	<u>Sample Description</u>	<u>Sample Wt. Gram</u>	<u>Nb-93 µg/g</u>	<u>Nb-94 µg/g</u>
79785	W03699121INC	SN-20	0.6851	11.5	<.03
79788	W03699151INC	SN-11R	0.4889	0.13	<.03

Nb Analysis. The samples of beryllium were dissolved in 7 M HCl/0.2M HF. Samples were prepared for ICP-MS analysis using Rh-103 as an internal standard to correct for drift. A 50 ppb calibration standard was used as a check standard. At the end of the run the check standard was measured to be 51.9 ppb. Calibration standards were prepared by dilution of a High Purity Nb 10 µg/ml standard (expiration date May 2001). Natural zirconium and molybdenum impurities found in the beryllium samples were used to correct mass 94 interferences for niobium 94. Minimum limits of detection are reported for Nb-94. The total estimated error, <5%, is calculated from limits of quantification and drift values.

If you have any questions, please feel free to call me at 208-533-7318.

Sincerely,

John Krsul
Manager, Analytical Laboratory

Att.: Final Reports

pc: Bruce Becker MS 3920
 Charlie Brooks MS 7106
 Mike Carboneau MS 3885
 Teresa Carlson
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 Dan Cummings
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 John Logan MS 3885
 Carlan Mullen MS 4142
 Doug Porter ANL-W
 Rocky Warren

Appendix C

**Oak Ridge Isotope GENeration and Depletion Code Version 2
Input Model for the Advanced Test Reactor
Beryllium Blocks from Core 1**

Appendix C

Oak Ridge Isotope GENeration and Depletion Code Version 2 Input Model for the Advanced Test Reactor Beryllium Blocks from Core 1

Appendix C is a listing of the input file used with the Oak Ridge Isotope GENeration and Depletion Code Version 2 to model activation and transmutation in the beryllium reflector blocks from Core 1 of the Advanced Test Reactor.

```
-1
-1
-1
TIT *ATR - Beryllium Block Calculation for Jean Holdren
TIT *INPUT: Core1.inp ACTIVATION ANALYSIS FOR BLOCKS IN CORE 1
TIT *OUTPUT: CORE1.out
TIT One of the two blocks in NW lobe
TIT One of two blocks in NE lobe
TIT One of two blocks in SW lobe
TIT One of the two blocks in SE lobe
TIT Input deck was created on 2/04/2002
TIT *COMPONENT: Core 1 (one block per lobe with each lobe modeled)
TIT *IRRADIATION: CORE 1
TIT *IRRADIATION: 2/1/1968 to 9/9/72 = 1,682 days or 4.60517 years
TIT Dates: 1/1/1900 = Reference date = YR 1900.0
TIT 2/1/1968 = Start Time 24,869 D = YR 1968.089066
TIT 9/9/1972 = SCRAM 26,551 D = YR 1972.694229
TIT Disposal Date 12/1/1976 = 28,095 Days = YR 1976.921561
TIT Decay date 9/15/2001 = 37,149 Days = YR 2001.710591
TIT *MATERIAL: Beryllium metal is considered but no non-Be hardware
TIT *MATERIAL Initial metal mass is 81,420 grams per block
BAS *Four Single ATR Beryllium Block Calculations for Core 1
LIP 0 0 0
LPU 30060 40090 60120 60130 70140
      80170 270590 270600 270601 280580
      280590 280600 280610 280620 280630
      280640 290630 300660 410930 410940
      420940 420980 420990 430990           -1
LPU 902320 902330 912330 922330 922340
      922350 922360 922370 922380 922390
      922400 932350 932360 932370 932380
      942370 942380 942390 942400 942410
      942420 942430 952410 952420 952430
      962420 962430 962440 962450 962460
      962470 962480 972490 982490 982500
      982510 982520           -1
LIB 0 1 2 3 -204 -908 909     9 50 0 4 0
PHO 101 102 103 10
RDA -----
RDA * Single Beryllium Block in each of 4 lobes in Core 1
RDA * Start of Irradiation = Feb 1, 1968 = Day 24,869 = 1968.089066 YR
RDA * SCRAM = Sept 9, 1972 = Day 26,551 = 1972.694229 YR
RDA * Est. Disposal Date = Dec 1, 1976 = Day 28,095 = 1976.921561 YR
RDA * Common Decay Date = Sept 15, 2001= Day 37,149 = 2001.710591 YR
RDA -----
OPTL 8 8 8 8 2   8 2 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTA 8 8 8 8 2   8 2 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTF 8 8 8 8 2   8 2 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
CUT 7 1.0E-06 28 1.0E-75 -1
```

```

INP -1 1 -1 -1 1 1
MOV -1 1 0 0.0 Zero inventory for dummy decay
DEC 1968.089066 1 2 5 2 Dummy decay to set clock to Feb 1, 1968
MOV -1 1 0 1.0 Reset Vector 1 with the initial inventory
ADD 2 1 0 1.0 Change time to 1968.089066 YR for Vector 1
BUP
RDA * * * * * Calculation for Blocks NWL and NWR in Core 1
IRF 1968.50 1.5114E+14 1 2 5 0 Do not reset clock
IRF 1969.00 1.5114E+14 2 3 5 0 Time=Jan 1, 1969
IRF 1969.50 1.5114E+14 3 4 5 0
IRF 1970.00 1.5114E+14 4 5 5 0 Time=Jan 1, 1970
IRF 1970.50 1.5114E+14 5 6 5 0
IRF 1971.00 1.5114E+14 6 7 5 0 Time=Jan 1, 1971
IRF 1971.50 1.5114E+14 7 8 5 0
IRF 1972.00 1.5114E+14 8 9 5 0 Time=Jan 1, 1972
IRF 1972.694229 1.5114E+14 9 10 5 0 SCRAM on 9/9/1972
BUP
DEC 1976.921561 10 11 5 0 Disposal date of 12/1/1976
DEC 2001.710591 11 12 5 0 Decay date of 9/15/2001
MOV 11 -2 0 1.0 Vector 11 results for Blocks NWL and NWR in -2
MOV 12 -3 0 1.0 Vector 12 saved in -3
MOV -1 1 0 0.0 Zero inventory for dummy decay
DEC 1968.089066 1 2 5 2 Dummy decay to set clock to Feb 1, 1968
MOV -1 1 0 1.0 Reset Vector 1 with the initial inventory
ADD 2 1 0 1.0 Change time to 1968.08906 YR for Vector 1
BUP
RDA * * * * * Calculation for Blocks NEL and NER in Core 1
IRF 1968.50 1.4629E+14 1 2 5 0 Do not reset clock
IRF 1969.00 1.4629E+14 2 3 5 0 Time=Jan 1, 1969
IRF 1969.50 1.4629E+14 3 4 5 0
IRF 1970.00 1.4629E+14 4 5 5 0 Time=Jan 1, 1970
IRF 1970.50 1.4629E+14 5 6 5 0
IRF 1971.00 1.4629E+14 6 7 5 0 Time=Jan 1, 1971
IRF 1971.50 1.4629E+14 7 8 5 0
IRF 1972.00 1.4629E+14 8 9 5 0 Time=Jan 1, 1972
IRF 1972.694229 1.4629E+14 9 10 5 0 SCRAM on 9/9/1972
BUP
DEC 1976.921561 10 11 5 0 Disposal date of 12/1/1976
DEC 2001.710591 11 12 5 0 Decay date of 9/15/2001
MOV 11 -4 0 1.0 Vector 11 results for Blocks NER and NEL in -4
MOV 12 -5 0 1.0 Vector 12 saved in -5
MOV -1 1 0 0.0 Zero inventory for dummy decay
DEC 1968.089066 1 2 5 2 Dummy decay to set clock to Feb 1, 1968
MOV -1 1 0 1.0 Reset Vector 1 with the initial inventory
ADD 2 1 0 1.0 Change time to 1968.08906 YR for Vector 1
BUP
RDA * * * * * Calculation for Blocks SWL and SWR in Core 1
IRF 1968.50 1.4635E+14 1 2 5 0 Do not reset clock
IRF 1969.00 1.4635E+14 2 3 5 0 Time=Jan 1, 1969
IRF 1969.50 1.4635E+14 3 4 5 0
IRF 1970.00 1.4635E+14 4 5 5 0 Time=Jan 1, 1970
IRF 1970.50 1.4635E+14 5 6 5 0
IRF 1971.00 1.4635E+14 6 7 5 0 Time=Jan 1, 1971
IRF 1971.50 1.4635E+14 7 8 5 0
IRF 1972.00 1.4635E+14 8 9 5 0 Time=Jan 1, 1972
IRF 1972.694229 1.4635E+14 9 10 5 0 SCRAM on 9/9/1972
BUP
DEC 1976.921561 10 11 5 0 Disposal date of 12/1/1976
DEC 2001.710591 11 12 5 0 Decay date of 9/15/2001
MOV 11 -6 0 1.0 Vector 11 results for Blocks SWL and SWR in -6
MOV 12 -7 0 1.0 Vector 12 saved in -7
MOV -1 1 0 0.0 Zero inventory for dummy decay
DEC 1968.089066 1 2 5 2 Dummy decay to set clock to Feb 1, 1968

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MOV -1 1 0 1.0          Reset Vector 1 with the initial inventory
ADD 2 1 0 1.0          Change time to 1968.08906 YR for Vector 1
BUP
RDA * * * * * Calculation for Blocks SEL and SER in Core 1
IRF 1968.50 1.4655E+14 1 2 5 0 Do not reset clock
IRF 1969.00 1.4655E+14 2 3 5 0 Time=Jan 1, 1969
IRF 1969.50 1.4655E+14 3 4 5 0
IRF 1970.00 1.4655E+14 4 5 5 0 Time=Jan 1, 1970
IRF 1970.50 1.4655E+14 5 6 5 0
IRF 1971.00 1.4655E+14 6 7 5 0 Time=Jan 1, 1971
IRF 1971.50 1.4655E+14 7 8 5 0
IRF 1972.00 1.4655E+14 8 9 5 0 Time=Jan 1, 1972
IRF 1972.694229 1.4655E+14 9 10 5 0 SCRAM on 9/9/1972
BUP
DEC 1976.921561 10 11 5 0 Disposal date of 12/1/1976
DEC 2001.710591 11 12 5 0 Decay date of 9/15/2001
MOV 11 -8 0 1.0          Vector 11 results for Blocks SEL and SER in -8
MOV 12 -9 0 1.0          Vector 12 saved in -9
MOV -1 1 0 1.0          Move initial inventory into Vector 1
MOV -2 2 0 1.0          NW block for 12/1/1976
MOV -3 3 0 1.0          NW block for 9/15/2001
MOV -4 4 0 1.0          NE block for 12/1/1976
MOV -5 5 0 1.0          NE block for 9/15/2001
MOV -6 6 0 1.0          SW block for 12/1/1976
MOV -7 7 0 1.0          SW block for 9/15/2001
MOV -8 8 0 1.0          SE block for 12/1/1976
MOV -9 9 0 1.0          SE block for 9/15/2001
RDA * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
RDA * Start of Irradiation = Feb 1, 1968 = 1968.089066 YR
RDA * Scram date        = Sept 9, 1972 = 1972.694229 YR
RDA * Est. Disposal Date = Dec 1, 1976 = 1976.921561 YR
RDA * Common Decay Date = Sept 15, 2001 = 2001.710591 YR
RDA * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
HED 1 INIT
OUT 9 1 0 0
STP 4          Modified Cross-Section Data Follows
204 30060 1.261E-02 0.000E+00 3.065E+02 4.435E-04 0.000E+00 0.000E+00 -1.0
204 40090 2.860E-03 1.227E-02 4.557E-03 3.354E-09 0.000E+00 0.000E+00 -1.0
204 60120 1.464E-03 0.000E+00 5.651E-05 0.000E+00 0.000E+00 0.000E+00 -1.0
204 60130 2.992E-04 2.667E-05 7.969E-04 0.000E+00 0.000E+00 0.000E+00 -1.0
204 70140 2.466E-02 0.000E+00 1.031E-02 6.156E-01 0.000E+00 0.000E+00 -1.0
204 80170 0.000E+00 0.000E+00 9.456E-02 0.000E+00 0.000E+00 0.000E+00 -1.0
204 270590 8.030E+00 0.000E+00 1.691E-05 1.585E-04 2.622E+00 0.000E+00 -1.0
204 270600 7.607E-01 0.000E+00 6.805E-06 2.712E-05 0.000E+00 0.000E+00 -1.0
204 270601 2.360E+01 0.000E+00 1.257E-05 1.936E-04 0.000E+00 0.000E+00 -1.0
204 280580 1.509E+00 2.491E-06 1.874E-03 5.833E-03 0.000E+00 0.000E+00 -1.0
204 280590 3.266E+01 0.000E+00 5.868E+00 1.457E-02 0.000E+00 0.000E+00 -1.0
204 280600 9.237E-01 6.102E-06 4.153E-04 3.091E-04 0.000E+00 0.000E+00 -1.0
204 280610 8.377E-01 0.000E+00 7.604E-04 2.855E-04 0.000E+00 0.000E+00 -1.0
204 280620 4.648E+00 0.000E+00 1.240E-05 3.065E-05 0.000E+00 0.000E+00 -1.0
204 280630 7.532E+00 0.000E+00 1.463E-05 3.114E-06 0.000E+00 0.000E+00 -1.0
204 280640 4.962E-01 4.942E-05 6.868E-07 2.779E-07 0.000E+00 0.000E+00 -1.0
204 290630 1.559E+00 0.000E+00 2.431E-05 2.670E-03 0.000E+00 0.000E+00 -1.0
204 300660 3.046E-01 0.000E+00 1.848E-06 5.186E-05 0.000E+00 0.000E+00 -1.0
204 410930 6.247E-01 0.000E+00 6.485E-06 3.939E-05 1.012E-01 0.000E+00 -1.0
204 410940 7.917E+00 0.000E+00 0.000E+00 6.025E-05 0.000E+00 0.000E+00 -1.0
204 420940 3.328E-01 0.000E+00 2.023E-04 5.256E-05 0.000E+00 0.000E+00 -1.0
204 420980 2.366E-01 0.000E+00 2.023E-05 2.450E-06 0.000E+00 0.000E+00 -1.0
204 420990 9.414E-01 1.209E-03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 -1.0
204 430990 1.424E+01 0.000E+00 0.000E+00 1.596E-04 0.000E+00 0.000E+00 -1.0
908 902320 4.649E+00 1.638E-03 1.375E-05 9.813E-03 0.000E+00 0.000E+00 -1.0
908 902330 4.464E+02 8.036E-03 3.658E-05 6.993E+00 0.000E+00 0.000E+00 -1.0
908 912330 3.505E+01 4.703E-04 5.312E-06 6.260E-02 1.234E+01 0.000E+00 -1.0

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908	922330	1.863E+01	5.859E-04	2.755E-07	1.863E+02	0.000E+00	0.000E+00	-1.0
908	922340	4.907E+01	1.636E-04	1.928E-06	3.759E-01	0.000E+00	0.000E+00	-1.0
908	922350	3.412E+01	8.369E-04	6.097E-07	1.853E+02	0.000E+00	0.000E+00	-1.0
908	922360	1.075E+01	8.557E-04	9.463E-06	2.171E-01	0.000E+00	0.000E+00	-1.0
908	922370	1.553E+02	2.505E-03	1.935E-05	9.296E-01	0.000E+00	0.000E+00	-1.0
908	922380	8.256E+00	1.623E-03	8.289E-06	4.084E-02	0.000E+00	0.000E+00	-1.0
908	922390	1.109E+01	7.098E-03	5.187E-05	1.149E+01	0.000E+00	0.000E+00	-1.0
908	922400	5.713E+00	3.586E-03	5.357E-05	3.055E-02	0.000E+00	0.000E+00	-1.0
908	932350	5.679E+02	4.414E-04	5.417E-06	2.673E-01	1.472E+02	0.000E+00	-1.0
908	932360	3.343E+01	1.332E-03	2.903E-06	8.515E+02	0.000E+00	0.000E+00	-1.0
908	932370	8.035E+01	1.509E-04	1.235E-06	2.402E-01	0.000E+00	2.248E-04	-1.0
908	932380	3.343E+01	1.578E-03	5.868E-06	7.044E+02	0.000E+00	0.000E+00	-1.0
908	942370	1.677E+02	5.344E-04	1.082E-06	9.197E+02	0.000E+00	0.000E+00	-1.0
908	942380	1.674E+02	4.669E-04	7.484E-06	5.951E+00	0.000E+00	0.000E+00	-1.0
908	942390	1.331E+02	3.493E-04	4.697E-07	2.967E+02	0.000E+00	0.000E+00	-1.0
908	942400	3.063E+02	1.540E-04	1.233E-06	3.185E-01	0.000E+00	0.000E+00	-1.0
908	942410	1.337E+02	2.297E-03	2.779E-06	3.738E+02	0.000E+00	0.000E+00	-1.0
908	942420	3.899E+01	6.723E-04	4.502E-06	1.969E-01	0.000E+00	0.000E+00	-1.0
908	942430	9.210E+01	5.716E-03	3.227E-05	7.050E+01	0.000E+00	0.000E+00	-1.0
908	952410	2.589E+02	1.264E-04	1.239E-06	1.612E+00	1.084E+01	0.000E+00	-1.0
908	952420	4.965E+02	1.266E-03	5.298E-06	2.445E+03	0.000E+00	0.000E+00	-1.0
908	952430	7.206E+01	8.249E-05	6.952E-07	1.882E-01	5.416E+01	0.000E+00	-1.0
908	962420	9.591E+00	1.917E-05	3.245E-08	1.095E+00	0.000E+00	0.000E+00	-1.0
908	962430	1.211E+02	2.142E-03	6.058E-06	2.380E+02	0.000E+00	0.000E+00	-1.0
908	962440	1.905E+01	3.982E-04	6.110E-06	7.512E-01	0.000E+00	0.000E+00	-1.0
908	962450	1.211E+02	2.238E-03	7.180E-06	6.093E+02	0.000E+00	0.000E+00	-1.0
908	962460	4.087E+00	1.768E-03	1.591E-05	3.203E-01	0.000E+00	0.000E+00	-1.0
908	962470	3.809E+01	3.453E-03	1.476E-05	5.082E+01	0.000E+00	0.000E+00	-1.0
908	962480	8.545E+00	1.945E-03	3.090E-05	5.913E-01	0.000E+00	0.000E+00	-1.0
908	972490	6.133E+02	2.206E-03	2.308E-05	4.680E-01	0.000E+00	0.000E+00	-1.0
908	982490	1.577E+02	2.349E-03	1.535E-05	5.662E+02	0.000E+00	0.000E+00	-1.0
908	982500	9.043E+02	1.147E-03	1.066E-05	5.351E-01	0.000E+00	0.000E+00	-1.0
908	982520	7.930E+00	9.229E-04	9.440E-06	1.384E+01	0.000E+00	0.000E+00	-1.0

Chemical composition of the ATR beryllium metal follows:

1	10010	0.0000E+00	0	0.0	H1
1	10020	0.0000E+00	0	0.0	H2
1	20030	0.0000E+00	0	0.0	He3
1	20040	0.0000E+00	0	0.0	He4
1	30060	9.6331E-08	0	0.0	Li6
1	30070	8.1420E-02	0	0.0	Li7
1	40090	7.9846E+04	0	0.0	Be9 = balance
1	40100	0.0000E+00	0	0.0	Be10
1	50100	2.8762E-02	0	0.0	B10
1	50110	1.2729E-01	0	0.0	B11
1	60120	5.9936E+01	0	0.0	C12 C=745ppm
1	60130	7.2236E-01	0	0.0	C13
1	70140	1.6657E+01	0	0.0	N14 N=205ppm
1	70150	6.6280E-02	0	0.0	N15
1	80160	1.0247E+03	0	0.0	O16
1	80170	4.3653E-01	0	0.0	O17
1	80180	2.3110E+00	0	0.0	O18
1	90190	5.6316E+00	0	0.0	F19
1	100200	1.0400E+02	0	0.0	Ne20
1	100210	3.2587E-01	0	0.0	Ne21
1	100220	1.1696E+01	0	0.0	Ne22
1	110230	7.1188E-02	0	0.0	Na23
1	120240	2.8560E+00	0	0.0	Mg24
1	120250	3.7663E-01	0	0.0	Mg25
1	120260	4.3126E-01	0	0.0	Mg26
1	130270	2.8972E+01	0	0.0	Al27
1	140280	2.3156E+01	0	0.0	Si28
1	140290	3.0362E+00	0	0.0	Si29

1	140300	3.4581E+00	0	0.0	Si30
1	150310	4.0710E+00	0	0.0	P31
1	160320	5.7857E-01	0	0.0	S32
1	160330	4.7094E-03	0	0.0	S33
1	160340	2.7236E-02	0	0.0	S34
1	160350	0.0000E+00	0	0.0	S35
1	160360	1.3700E-04	0	0.0	S36
1	170350	3.0425E+00	0	0.0	C135
1	170360	0.0000E+00	0	0.0	C136
1	170370	1.0285E+00	0	0.0	C137
1	180360	1.5736E-03	0	0.0	Ar36
1	180370	0.0000E+00	0	0.0	Ar37
1	180380	3.1052E-04	0	0.0	Ar38
1	180390	0.0000E+00	0	0.0	Ar39
1	180400	5.1676E-01	0	0.0	Ar40
1	190390	9.8900E-01	0	0.0	K39
1	190400	1.2726E-04	0	0.0	K40
1	190410	7.5034E-02	0	0.0	K41
1	200400	1.5740E+01	0	0.0	Ca40
1	200410	0.0000E+00	0	0.0	Ca41
1	200420	1.1031E-01	0	0.0	Ca42
1	200430	2.3564E-02	0	0.0	Ca43
1	200440	3.7258E-01	0	0.0	Ca44
1	200450	0.0000E+00	0	0.0	Ca45
1	200460	7.4690E-04	0	0.0	Ca46
1	200470	0.0000E+00	0	0.0	Ca47
1	200480	3.6436E-02	0	0.0	Ca48
1	210450	1.8727E-01	0	0.0	Sc45
1	220460	3.8550E-01	0	0.0	Ti46
1	220470	3.5941E-01	0	0.0	Ti47
1	220480	3.7108E+00	0	0.0	Ti48
1	220490	2.8231E-01	0	0.0	Ti49
1	220500	2.8284E-01	0	0.0	Ti50
1	230500	6.8319E-04	0	0.0	V50
1	230510	2.7804E-01	0	0.0	V51
1	240500	3.1432E-01	0	0.0	Cr50
1	240510	0.0000E+00	0	0.0	Cr51
1	240520	6.3038E+00	0	0.0	Cr52
1	240530	7.2846E-01	0	0.0	Cr53
1	240540	1.8477E-01	0	0.0	Cr54
1	250550	4.6138E+00	0	0.0	Mn55
1	260540	6.9558E+00	0	0.0	Fe54
1	260550	0.0000E+00	0	0.0	Fe55
1	260560	1.1214E+02	0	0.0	Fe56
1	260570	2.6133E+00	0	0.0	Fe57
1	260580	3.5456E-01	0	0.0	Fe58
1	270590	9.7704E-01	0	0.0	Co59 = 12ppm
1	280580	1.2392E+01	0	0.0	Ni58
1	280590	0.0000E+00	0	0.0	Ni59
1	280600	4.9009E+00	0	0.0	Ni60
1	280610	2.1572E-01	0	0.0	Ni61
1	280620	6.9657E-01	0	0.0	Ni62
1	280630	0.0000E+00	0	0.0	Ni63
1	280640	1.8226E-01	0	0.0	Ni64
1	290630	4.8801E+00	0	0.0	Cu63
1	290640	0.0000E+00	0	0.0	Cu64
1	290650	2.2442E+00	0	0.0	Cu65
1	300640	5.0287E-01	0	0.0	Zn64
1	300650	0.0000E+00	0	0.0	Zn65
1	300660	2.9771E-01	0	0.0	Zn66
1	300670	4.4412E-02	0	0.0	Zn67
1	300680	2.0668E-01	0	0.0	Zn68
1	300690	0.0000E+00	0	0.0	Zn69

1	300700	6.7903E-03	0	0.0	Zn70
1	310690	4.1576E-02	0	0.0	Ga69
1	310700	0.0000E+00	0	0.0	Ga70
1	310710	2.8391E-02	0	0.0	Ga71
1	320700	8.0345E-02	0	0.0	Ge70
1	320710	0.0000E+00	0	0.0	Ge71
1	320720	1.1046E-01	0	0.0	Ge72
1	320730	3.1880E-02	0	0.0	Ge73
1	320740	1.5123E-01	0	0.0	Ge74
1	320750	0.0000E+00	0	0.0	Ge75
1	320760	3.3191E-02	0	0.0	Ge76
1	330750	1.4509E-01	0	0.0	As75
1	340740	1.6347E-03	0	0.0	Se74
1	340750	0.0000E+00	0	0.0	Se75
1	340760	1.6975E-02	0	0.0	Se76
1	340770	1.4364E-02	0	0.0	Se77
1	340780	4.5182E-02	0	0.0	Se78
1	340790	0.0000E+00	0	0.0	Se79
1	340800	9.7983E-02	0	0.0	Se80
1	340810	0.0000E+00	0	0.0	Se81
1	340820	1.7913E-02	0	0.0	Se82
1	350790	2.1197E+00	0	0.0	Br79
1	350800	0.0000E+00	0	0.0	Br80
1	350810	2.1142E+00	0	0.0	Br81
1	360780	2.2566E-02	0	0.0	Kr78
1	360790	0.0000E+00	0	0.0	Kr79
1	360800	1.4879E-01	0	0.0	Kr80
1	360810	0.0000E+00	0	0.0	Kr81
1	360820	7.8627E-01	0	0.0	Kr82
1	360830	7.8900E-01	0	0.0	Kr83
1	360840	3.9578E+00	0	0.0	Kr84
1	360850	0.0000E+00	0	0.0	Kr85
1	360860	1.2298E+00	0	0.0	Kr86
1	370850	4.5334E-01	0	0.0	Rb85
1	370860	0.0000E+00	0	0.0	Rb86
1	370870	1.7902E-01	0	0.0	Rb87
1	380840	2.6200E-03	0	0.0	Sr84
1	380850	0.0000E+00	0	0.0	Sr85
1	380860	4.7229E-02	0	0.0	Sr86
1	380870	3.3919E-02	0	0.0	Sr87
1	380880	4.0475E-01	0	0.0	Sr88
1	390890	8.1420E-02	0	0.0	Y89
1	400900	1.5777E+00	0	0.0	Zr90
1	400910	3.4788E-01	0	0.0	Zr91
1	400920	5.3759E-01	0	0.0	Zr92
1	400930	0.0000E+00	0	0.0	Zr93
1	400940	5.5664E-01	0	0.0	Zr94
1	400950	0.0000E+00	0	0.0	Zr95
1	400960	9.1586E-02	0	0.0	Zr96
1	410930	9.5261E-01	0	0.0	Nb93
1	420920	1.1576E-01	0	0.0	Mo92
1	420930	0.0000E+00	0	0.0	Mo93
1	420940	7.3725E-02	0	0.0	Mo94
1	420950	1.2824E-01	0	0.0	Mo95
1	420960	1.3577E-01	0	0.0	Mo96
1	420970	7.8545E-02	0	0.0	Mo97
1	420980	2.0051E-01	0	0.0	Mo98
1	420990	0.0000E+00	0	0.0	Mo99
1	421000	8.1653E-02	0	0.0	Mo100
1	430990	0.0000E+00	0	0.0	Tc99
1	440960	2.1403E-02	0	0.0	Ru96
1	440970	0.0000E+00	0	0.0	Ru97
1	440980	7.3354E-03	0	0.0	Ru98

1	440990	5.0597E-02	0	0.0	Ru99
1	441000	5.0706E-02	0	0.0	Ru100
1	441010	6.9503E-02	0	0.0	Ru101
1	441020	1.2971E-01	0	0.0	Ru102
1	441030	0.0000E+00	0	0.0	Ru103
1	441040	7.7845E-02	0	0.0	Ru104
1	451030	8.0904E-02	0	0.0	Rh103
1	461020	3.9766E-03	0	0.0	Pd102
1	461030	0.0000E+00	0	0.0	Pd103
1	461040	4.4282E-02	0	0.0	Pd104
1	461050	8.9616E-02	0	0.0	Pd105
1	461060	1.1073E-01	0	0.0	Pd106
1	461070	0.0000E+00	0	0.0	Pd107
1	461080	1.0922E-01	0	0.0	Pd108
1	461090	0.0000E+00	0	0.0	Pd109
1	461100	4.9275E-02	0	0.0	Pd110
1	471070	9.0633E-02	0	0.0	Ag107
1	471080	0.0000E+00	0	0.0	Ag108
1	471090	8.5777E-02	0	0.0	Ag109
1	481060	9.5888E-04	0	0.0	Cd106
1	481070	0.0000E+00	0	0.0	Cd107
1	481080	6.9560E-04	0	0.0	Cd108
1	481090	0.0000E+00	0	0.0	Cd109
1	481100	9.9427E-03	0	0.0	Cd110
1	481110	1.0282E-02	0	0.0	Cd111
1	481120	1.9558E-02	0	0.0	Cd112
1	481130	9.9930E-03	0	0.0	Cd113
1	481140	2.3702E-02	0	0.0	Cd114
1	481150	0.0000E+00	0	0.0	Cd115
1	481160	6.2876E-03	0	0.0	Cd116
1	491130	2.3594E-04	0	0.0	In113
1	491140	0.0000E+00	0	0.0	In114
1	491150	5.3440E-03	0	0.0	In115
1	501120	2.2336E-03	0	0.0	Sn112
1	501130	0.0000E+00	0	0.0	Sn113
1	501140	1.5234E-03	0	0.0	Sn114
1	501150	8.5115E-04	0	0.0	Sn115
1	501160	3.4652E-02	0	0.0	Sn116
1	501170	1.8474E-02	0	0.0	Sn117
1	501180	5.8758E-02	0	0.0	Sn118
1	501190	2.0991E-02	0	0.0	Sn119
1	501200	8.0403E-02	0	0.0	Sn120
1	501210	0.0000E+00	0	0.0	Sn121
1	501220	1.1613E-02	0	0.0	Sn122
1	501230	0.0000E+00	0	0.0	Sn123
1	501240	1.4761E-02	0	0.0	Sn124
1	511210	1.1169E-02	0	0.0	Sb121
1	511220	0.0000E+00	0	0.0	Sb122
1	511230	8.4261E-03	0	0.0	Sb123
1	521200	3.4505E-03	0	0.0	Te120
1	521210	0.0000E+00	0	0.0	Te121
1	521220	9.5640E-02	0	0.0	Te122
1	521230	3.3692E-02	0	0.0	Te123
1	521240	1.7978E-01	0	0.0	Te124
1	521250	2.6938E-01	0	0.0	Te125
1	521260	7.2194E-01	0	0.0	Te126
1	521270	0.0000E+00	0	0.0	Te127
1	521280	1.2281E+00	0	0.0	Te128
1	521290	0.0000E+00	0	0.0	Te129
1	521300	1.3327E+00	0	0.0	Te130
1	531270	8.1420E-01	0	0.0	I127
1	541240	4.1290E-02	0	0.0	Xe124
1	541250	0.0000E+00	0	0.0	Xe125

1	541260	3.7760E-02	0	0.0	Xe126
1	541270	0.0000E+00	0	0.0	Xe127
1	541280	8.1407E-01	0	0.0	Xe128
1	541290	1.1340E+01	0	0.0	Xe129
1	541300	1.7748E+00	0	0.0	Xe130
1	541310	9.2475E+00	0	0.0	Xe131
1	541320	1.1823E+01	0	0.0	Xe132
1	541330	0.0000E+00	0	0.0	Xe133
1	541340	4.6404E+00	0	0.0	Xe134
1	541350	0.0000E+00	0	0.0	Xe135
1	541360	4.0304E+00	0	0.0	Xe136
1	551330	1.6393E-02	0	0.0	Cs133 = 0.20ppm
1	561300	4.8987E-04	0	0.0	Ba130
1	561310	0.0000E+00	0	0.0	Ba131
1	561320	4.7394E-04	0	0.0	Ba132
1	561330	0.0000E+00	0	0.0	Ba133
1	561340	1.1528E-02	0	0.0	Ba134
1	561350	3.1641E-02	0	0.0	Ba135
1	561360	3.7952E-02	0	0.0	Ba136
1	561370	5.4692E-02	0	0.0	Ba137
1	561380	3.5174E-01	0	0.0	Ba138
1	571380	7.2751E-05	0	0.0	La138
1	571390	8.1347E-02	0	0.0	La139
1	581360	1.5005E-04	0	0.0	Ce136
1	581370	0.0000E+00	0	0.0	Ce137
1	581380	2.0034E-04	0	0.0	Ce138
1	581390	0.0000E+00	0	0.0	Ce139
1	581400	7.1892E-02	0	0.0	Ce140
1	581410	0.0000E+00	0	0.0	Ce141
1	581420	9.1780E-03	0	0.0	Ce142
1	591410	8.1420E-02	0	0.0	Pr141
1	601420	1.0866E-01	0	0.0	Nd142
1	601430	4.9127E-02	0	0.0	Nd143
1	601440	9.6667E-02	0	0.0	Nd144
1	601450	3.3946E-02	0	0.0	Nd145
1	601460	7.0790E-02	0	0.0	Nd146
1	601470	0.0000E+00	0	0.0	Nd147
1	601480	2.4045E-02	0	0.0	Nd148
1	601490	0.0000E+00	0	0.0	Nd149
1	601500	2.3862E-02	0	0.0	Nd150
1	611450	0.0000E+00	0	0.0	Pm145
1	621440	1.2080E-03	0	0.0	Sm144
1	621450	0.0000E+00	0	0.0	Sm145
1	621460	0.0000E+00	0	0.0	Sm146
1	621470	5.9668E-03	0	0.0	Sm147
1	621480	4.5256E-03	0	0.0	Sm148
1	621490	5.5641E-03	0	0.0	Sm149
1	621500	3.0037E-03	0	0.0	Sm150
1	621510	0.0000E+00	0	0.0	Sm151
1	621520	1.0982E-02	0	0.0	Sm152
1	621530	0.0000E+00	0	0.0	Sm153
1	621540	9.4597E-03	0	0.0	Sm154
1	631510	0.0	0	0.0	Eu151=0
1	631520	0.0000E+00	0	0.0	Eu152=0
1	631530	0.0	0	0.0	Eu153=0
1	641520	3.1465E-05	0	0.0	Gd152
1	641530	0.0000E+00	0	0.0	Gd153
1	641540	3.4748E-04	0	0.0	Gd154
1	641550	2.3744E-03	0	0.0	Gd155
1	641560	3.3052E-03	0	0.0	Gd156
1	641570	2.5431E-03	0	0.0	Gd157
1	641580	4.0622E-03	0	0.0	Gd158
1	641590	0.0000E+00	0	0.0	Gd159

1	641600	3.6201E-03	0	0.0	Gd160
1	651590	8.1420E-02	0	0.0	Tb159
1	661560	9.3756E-06	0	0.0	Dy156
1	661570	0.0000E+00	0	0.0	Dy157
1	661580	1.5826E-05	0	0.0	Dy158
1	661590	0.0000E+00	0	0.0	Dy159
1	661600	3.7502E-04	0	0.0	Dy160
1	661610	3.0480E-03	0	0.0	Dy161
1	661620	4.1379E-03	0	0.0	Dy162
1	661630	4.0655E-03	0	0.0	Dy163
1	661640	4.6325E-03	0	0.0	Dy164
1	671650	8.1420E-02	0	0.0	Ho165
1	681620	5.5181E-05	0	0.0	Er162
1	681630	0.0000E+00	0	0.0	Er163
1	681640	6.4241E-04	0	0.0	Er164
1	681650	0.0000E+00	0	0.0	Er165
1	681660	1.3570E-02	0	0.0	Er166
1	681670	9.3249E-03	0	0.0	Er167
1	681680	1.0954E-02	0	0.0	Er168
1	681690	0.0000E+00	0	0.0	Er169
1	681700	6.1628E-03	0	0.0	Er170
1	691690	4.0710E-02	0	0.0	Tm169
1	701680	2.0546E-05	0	0.0	Yb168
1	701690	0.0000E+00	0	0.0	Yb169
1	701700	4.8778E-04	0	0.0	Yb170
1	701710	2.3004E-03	0	0.0	Yb171
1	701720	3.5436E-03	0	0.0	Yb172
1	701730	2.6235E-03	0	0.0	Yb173
1	701740	5.2054E-03	0	0.0	Yb174
1	701750	0.0000E+00	0	0.0	Yb175
1	701760	2.1028E-03	0	0.0	Yb176
1	711750	5.2866E-02	0	0.0	Lu175
1	711760	1.4137E-03	0	0.0	Lu176
1	721740	5.4417E-05	0	0.0	Hf174
1	721750	0.0000E+00	0	0.0	Hf175
1	721760	1.7688E-03	0	0.0	Hf176
1	721770	6.3577E-03	0	0.0	Hf177
1	721780	9.3801E-03	0	0.0	Hf178
1	721790	4.7097E-03	0	0.0	Hf179
1	721800	1.2197E-02	0	0.0	Hf180
1	731801	4.2072E-06	0	0.0	Ta180M
1	731810	3.5251E-02	0	0.0	Ta181
1	741800	7.2886E-03	0	0.0	W180
1	741810	0.0000E+00	0	0.0	W181
1	741820	1.6152E+00	0	0.0	W182
1	741830	8.8179E-01	0	0.0	W183
1	741840	1.9061E+00	0	0.0	W184
1	741850	0.0000E+00	0	0.0	W185
1	741860	1.7950E+00	0	0.0	W186
1	751850	1.9479E-02	0	0.0	Re185
1	751860	0.0000E+00	0	0.0	Re186
1	751870	3.2956E-02	0	0.0	Re187
1	761840	1.0031E-05	0	0.0	Os184
1	761850	0.0000E+00	0	0.0	Os185
1	761860	8.0102E-04	0	0.0	Os186
1	761870	8.1553E-04	0	0.0	Os187
1	761880	6.8153E-03	0	0.0	Os188
1	761890	8.2940E-03	0	0.0	Os189
1	761900	1.3672E-02	0	0.0	Os190
1	761910	0.0000E+00	0	0.0	Os191
1	761920	2.1457E-02	0	0.0	Os192
1	771910	1.5086E-04	0	0.0	Ir191
1	771920	0.0000E+00	0	0.0	Ir192

1	771930	2.5624E-04	0	0.0	Ir193
1	781900	8.0765E-04	0	0.0	Pt190
1	781910	0.0000E+00	0	0.0	Pt191
1	781920	6.4476E-02	0	0.0	Pt192
1	781930	0.0000E+00	0	0.0	Pt193
1	781940	2.7131E+00	0	0.0	Pt194
1	781950	2.8017E+00	0	0.0	Pt195
1	781960	2.1079E+00	0	0.0	Pt196
1	781970	0.0000E+00	0	0.0	Pt197
1	781980	6.0600E-01	0	0.0	Pt198
1	791970	2.0192E+00	0	0.0	Au197
1	801960	4.8596E-04	0	0.0	Hg196
1	801970	0.0000E+00	0	0.0	Hg197
1	801980	3.2728E-02	0	0.0	Hg198
1	801990	5.5590E-02	0	0.0	Hg199
1	802000	7.6366E-02	0	0.0	Hg200
1	802010	4.3856E-02	0	0.0	Hg201
1	802020	9.9500E-02	0	0.0	Hg202
1	802030	0.0000E+00	0	0.0	Hg203
1	802040	2.3098E-02	0	0.0	Hg204
1	812030	5.9674E-01	0	0.0	Tl203
1	812040	0.0000E+00	0	0.0	Tl204
1	812050	1.4388E+00	0	0.0	Tl205
1	822040	1.1221E-03	0	0.0	Pb204
1	822050	0.0000E+00	0	0.0	Pb205
1	822060	1.9505E-02	0	0.0	Pb206
1	822070	1.7973E-02	0	0.0	Pb207
1	822080	4.2820E-02	0	0.0	Pb208
1	832090	0.0000E+00	0	0.0	Bi209
2	902320	3.5662E-02	0	0.0	Th232
2	922340	1.3210E-04	0	0.0	U234
2	922350	1.7367E-02	0	0.0	U235
2	922360	0.0000E+00	0	0.0	U236
2	922370	0.0000E+00	0	0.0	U237
2	922380	2.4251E+00	0	0.0	U238 U=30ppm
0					

Appendix D

**Oak Ridge Isotope GENeration and Depletion Code Version 2
Input Model for the Advanced Test Reactor
Outer Shim Control Cylinders from Cores 1 and 2**

Appendix D

Oak Ridge Isotope GENeration and Depletion Code Version 2 Input Model for the Advanced Test Reactor Outer Shim Control Cylinders from Cores 1 and 2

Appendix D is a listing of the input file used with the Oak Ridge Isotope GENeration and Depletion Code Version 2 to model activation and transmutation in the outer shim control cylinders from Cores 1 and 2 of the Advanced Test Reactor.

```
-1
-1
-1
TIT *ATR - Beryllium OSCC Calculation for Jean Holdren
TIT *INPUT: OSCC.INP ACTIVATION ANALYSIS FOR 16 OSCCs IN CORE 1+2
TIT *OUTPUT: OSCC.OUT
TIT Input deck was created on 2/06/2002
TIT *COMPONENT: 16 OSCCs in Cores 1+2
TIT *IRRADIATION: 2/01/1968 to 4/11/1986 = 3,208 days or 8.783213 years
TIT Dates: 1/01/1900 = Reference date = YR 1900.0
TIT 2/01/1968 = Start 1 = YR 1968.089066
TIT 9/09/1972 = SCRAM 1 = YR 1972.694229
TIT 2/05/1973 = Start 2 = YR 1973.102177
TIT 4/11/1977 = SCRAM 2 = YR 1977.280227
TIT 9/01/1987 = Disposal date = YR 1987.670593
TIT 9/15/2001 = Decay date = YR 2001.710591
TIT * Beryllium metal is considered but no non-Be hardware
TIT * Initial metal mass is 120 lb per OSCC
TIT * Total OSCC mass in one lobe is 480 lb = 217,724 g
TIT * The mass of one block is 179.5 lb = 81,420 g
TIT * To scale the block input mass to a 4 OSCCs we need to
TIT * multiply the block input by 2.6741. See below
BAS * Calculation for 4 OSSCs for each lobe for Cores 1 plus 2
LIP 0 0 0
LPU 30060 40090 60120 60130 70140
     80170 270590 270600 270601 280580
     280590 280600 280610 280620 280630
     280640 290630 300660 410930 410940
     420940 420980 420990 430990      -1
LPU 902320 902330 912330 922330 922340
     922350 922360 922370 922380 922390
     922400 932350 932360 932370 932380
     942370 942380 942390 942400 942410
     942420 942430 952410 952420 952430
     962420 962430 962440 962450 962460
     962470 962480 972490 982490 982500
     982510 982520      -1
LIB 0 1 2 3 -204 -908 909 9 50 0 4 0
PHO 101 102 103 10
RDA *
RDA *-----*
RDA * 1/01/1900 = Reference date = YR 1900.0
RDA * 2/01/1968 = Start 1 = YR 1968.089066
RDA * 9/09/1972 = SCRAM 1 = YR 1972.694229
RDA * 2/05/1973 = Start 2 = YR 1973.102177
RDA * 4/11/1977 = SCRAM 2 = YR 1977.280227
RDA * 9/01/1987 = Disposal date = YR 1987.670593
RDA * 9/15/2001 = Decay date = YR 2001.710591
RDA *-----*
OPTL 8 8 8 8 2 8 2 8 8 8 8 8 8 8 8 8 8 8 8 8 8
```

```

OPTA 8 8 8 8 2   8 2 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTF 8 8 8 8 2   8 2 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
CUT 7 1.0E-06 28 1.0E-75 -1
INP -1 1 -1 -1 1 1
MOV -1 1 0 2.6741          Change the input block mass into 4 OSCCs
RDA                               Note: 4*120lb/179.5lb = 2.6741
MOV 1 -1 0 1.0           Save the new mass in Vector -1
RDA * * * * * * * * * * * * * * * * * * * * * * * * * * * *
RDA * Calculation for 4 OSCCs in NW Lobe for Cores 1+2
RDA
MOV -1 1 0 0.0          Zero inventory for dummy decay
DEC 1968.089066 1 2 5 2  Dummy decay to set clock to Feb 1, 1968
MOV -1 1 0 1.0           Reset Vector 1 with the initial inventory
ADD 2 1 0 1.0           Change time to 1968.089066 YR for Vector 1
BUP
IRF 1968.50 1.5114E+14 1 2 5 0 Do not reset clock
IRF 1969.00 1.5114E+14 2 3 5 0 Jan 1, 1969
IRF 1969.50 1.5114E+14 3 4 5 0
IRF 1970.00 1.5114E+14 4 5 5 0 Jan 1, 1970
IRF 1970.50 1.5114E+14 5 6 5 0
IRF 1971.00 1.5114E+14 6 7 5 0 Jan 1, 1971
IRF 1971.50 1.5114E+14 7 8 5 0
IRF 1972.00 1.5114E+14 8 9 5 0 Jan 1, 1972
IRF 1972.694229 1.5114E+14 9 10 5 0 SCRAM 1 End of Core 1
DEC 1973.102177          10 11 5 0 Feb 5, 1973 Start 2
IRF 1973.50 2.1084E+14 11 12 5 0
MOV 12 1 0 1.0           Move Vector 12 into 1
IRF 1974.00 2.1084E+14 1 2 5 0 Jan 1, 1974
IRF 1974.50 2.1084E+14 2 3 5 0
IRF 1975.00 2.1084E+14 3 4 5 0 Jan 1, 1975
IRF 1975.50 2.1084E+14 4 5 5 0
IRF 1976.00 2.1084E+14 5 6 5 0 Jan 1, 1976
IRF 1976.50 2.1084E+14 6 7 5 0
IRF 1977.00 2.1084E+14 7 8 5 0 Jan 1, 1977
IRF 1977.280227 2.1084E+14 8 9 5 0 SCRAM 2 End of Core 2
BUP
DEC 1987.670593 9 10 5 0 Disposal date of 9/1/1987
DEC 2001.710591 10 11 5 0 Common decay date of 9/15/2001
MOV 10 -2 0 1.0           Vector 10 saved in -2
MOV 11 -3 0 1.0           Vector 11 saved in -3
RDA * * * * * * * * * * * * * * * * * * * * * * * * * * * *
RDA * * * * * * * * * * * * * * * * * * * * * * * * * * * *
RDA * Calculation for 4 OSCCs in NE Lobe for Cores 1+2
RDA
MOV -1 1 0 0.0          Zero inventory for dummy decay
DEC 1968.089066 1 2 5 2  Dummy decay to set clock to Feb 1, 1968
MOV -1 1 0 1.0           Reset Vector 1 with the initial inventory
ADD 2 1 0 1.0           Change time to 1968.089066 YR for Vector 1
BUP
IRF 1968.50 1.4629E+14 1 2 5 0 Do not reset clock
IRF 1969.00 1.4629E+14 2 3 5 0 Jan 1, 1969
IRF 1969.50 1.4629E+14 3 4 5 0
IRF 1970.00 1.4629E+14 4 5 5 0 Jan 1, 1970
IRF 1970.50 1.4629E+14 5 6 5 0
IRF 1971.00 1.4629E+14 6 7 5 0 Jan 1, 1971
IRF 1971.50 1.4629E+14 7 8 5 0
IRF 1972.00 1.4629E+14 8 9 5 0 Jan 1, 1972
IRF 1972.694229 1.4629E+14 9 10 5 0 SCRAM 1 End of Core 1
DEC 1973.102177          10 11 5 0 Feb 5, 1973 Start 2
IRF 1973.50 1.3621E+14 11 12 5 0
MOV 12 1 0 1.0           Move Vector 12 into 1
IRF 1974.00 1.3621E+14 1 2 5 0 Jan 1, 1974
IRF 1974.50 1.3621E+14 2 3 5 0

```

```

IRF 1975.00 1.3621E+14 3 4 5 0 Jan 1, 1975
IRF 1975.50 1.3621E+14 4 5 5 0
IRF 1976.00 1.3621E+14 5 6 5 0 Jan 1, 1976
IRF 1976.50 1.3621E+14 6 7 5 0
IRF 1977.00 1.3621E+14 7 8 5 0 Jan 1, 1977
IRF 1977.280227 1.3621E+14 8 9 5 0 SCRAM 2 End of Core 2
BUP
DEC 1987.670593 9 10 5 0 Disposal date of 9/1/1987
DEC 2001.710591 10 11 5 0 Common decay date of 9/15/2001
MOV 10 -4 0 1.0 Vector 10 saved in -4
MOV 11 -5 0 1.0 Vector 11 saved in -5
RDA * * * * * * * * * * * * * * * * * * * * * * * * * * *
RDA * * * * * * * * * * * * * * * * * * * * * * * * * * *
RDA * Calculation for 4 OSCCs in SW Lobe for Cores 1+2
RDA
MOV -1 1 0 0.0 Zero inventory for dummy decay
DEC 1968.089066 1 2 5 2 Dummy decay to set clock to Feb 1, 1968
MOV -1 1 0 1.0 Reset Vector 1 with the initial inventory
ADD 2 1 0 1.0 Change time to 1968.089066 YR for Vector 1
BUP
IRF 1968.50 1.4635E+14 1 2 5 0 Do not reset clock
IRF 1969.00 1.4635E+14 2 3 5 0 Jan 1, 1969
IRF 1969.50 1.4635E+14 3 4 5 0
IRF 1970.00 1.4635E+14 4 5 5 0 Jan 1, 1970
IRF 1970.50 1.4635E+14 5 6 5 0
IRF 1971.00 1.4635E+14 6 7 5 0 Jan 1, 1971
IRF 1971.50 1.4635E+14 7 8 5 0
IRF 1972.00 1.4635E+14 8 9 5 0 Jan 1, 1972
IRF 1972.694229 1.4635E+14 9 10 5 0 SCRAM 1 End of Core 1
DEC 1973.102177 10 11 5 0 Feb 5, 1973 Start 2
IRF 1973.50 2.0920E+14 11 12 5 0
MOV 12 1 0 1.0 Move Vector 12 into 1
IRF 1974.00 2.0920E+14 1 2 5 0 Jan 1, 1974
IRF 1974.50 2.0920E+14 2 3 5 0
IRF 1975.00 2.0920E+14 3 4 5 0 Jan 1, 1975
IRF 1975.50 2.0920E+14 4 5 5 0
IRF 1976.00 2.0920E+14 5 6 5 0 Jan 1, 1976
IRF 1976.50 2.0920E+14 6 7 5 0
IRF 1977.00 2.0920E+14 7 8 5 0 Jan 1, 1977
IRF 1977.280227 2.0920E+14 8 9 5 0 SCRAM 2 End of Core 2
BUP
DEC 1987.670593 9 10 5 0 Disposal date of 9/1/1987
DEC 2001.710591 10 11 5 0 Common decay date of 9/15/2001
MOV 10 -6 0 1.0 Vector 10 saved in -6
MOV 11 -7 0 1.0 Vector 11 saved in -7
RDA * * * * * * * * * * * * * * * * * * * * * * * * * * *
RDA * * * * * * * * * * * * * * * * * * * * * * * * * * *
RDA * Calculation for 4 OSCCs in SE Lobe for Cores 1+2
RDA
MOV -1 1 0 0.0 Zero inventory for dummy decay
DEC 1968.089066 1 2 5 2 Dummy decay to set clock to Feb 1, 1968
MOV -1 1 0 1.0 Reset Vector 1 with the initial inventory
ADD 2 1 0 1.0 Change time to 1968.089066 YR for Vector 1
BUP
IRF 1968.50 1.4655E+14 1 2 5 0 Do not reset clock
IRF 1969.00 1.4655E+14 2 3 5 0 Jan 1, 1969
IRF 1969.50 1.4655E+14 3 4 5 0
IRF 1970.00 1.4655E+14 4 5 5 0 Jan 1, 1970
IRF 1970.50 1.4655E+14 5 6 5 0
IRF 1971.00 1.4655E+14 6 7 5 0 Jan 1, 1971
IRF 1971.50 1.4655E+14 7 8 5 0
IRF 1972.00 1.4655E+14 8 9 5 0 Jan 1, 1972
IRF 1972.694229 1.4655E+14 9 10 5 0 SCRAM 1 End of Core 1

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DEC 1973.102177      10  11  5  0 Feb 5, 1973 Start 2
IRF 1973.50  1.4043E+14  11  12  5  0
MOV 12  1  0  1.0                           Move Vector 12 into 1
IRF 1974.00  1.4043E+14  1   2  5  0 Jan 1, 1974
IRF 1974.50  1.4043E+14  2   3  5  0
IRF 1975.00  1.4043E+14  3   4  5  0 Jan 1, 1975
IRF 1975.50  1.4043E+14  4   5  5  0
IRF 1976.00  1.4043E+14  5   6  5  0 Jan 1, 1976
IRF 1976.50  1.4043E+14  6   7  5  0
IRF 1977.00  1.4043E+14  7   8  5  0 Jan 1, 1977
IRF 1977.280227 1.4043E+14  8   9  5  0 SCRAM 2 End of Core 2
BUP
DEC 1987.670593  9 10 5  0 Disposal date of 9/1/1987
DEC 2001.710591 10 11 5  0 Common decay date of 9/15/2001
MOV 10 -8  0  1.0                           Vector 10 saved in -8
MOV 11 -9  0  1.0                           Vector 11 saved in -9
RDA * * * * * * * * * * * * * * * * * * * * * * * * * *
RDA * * * * * * * * * * * * * * * * * * * * * * * * * *
MOV -1  1  0  0.0                           Zero inventory for dummy decay
DEC 1968.089066 1  2  5  2 Dummy decay to set clock to Feb 1, 1968
MOV -1  1  0  1.0                           Reset Vector 1 with the initial inventory
ADD  2  1  0  1.0                           Change time to 1968.089066 YR for Vector 1
RDA
MOV -2  2  0  1.0                           NW block for 9/1/1987
MOV -3  3  0  1.0                           NW block for 9/15/2001
MOV -4  4  0  1.0                           NE block for 9/1/1987
MOV -5  5  0  1.0                           NE block for 9/15/2001
MOV -6  6  0  1.0                           SW block for 9/1/1987
MOV -7  7  0  1.0                           SW block for 9/15/2001
MOV -8  8  0  1.0                           SE block for 9/1/1987
MOV -9  9  0  1.0                           SE block for 9/15/2001
RDA *-----*
OUT 9  1  0  0
STP 4
204 30060 1.683E-02 0.000E+00 4.093E+02 2.436E-04 0.000E+00 0.000E+00 -1.0
204 40090 3.795E-03 6.505E-03 2.478E-03 1.324E-09 0.000E+00 0.000E+00 -1.0
204 60120 1.796E-03 0.000E+00 3.300E-05 0.000E+00 0.000E+00 0.000E+00 -1.0
204 60130 3.952E-04 1.547E-05 7.969E-04 0.000E+00 0.000E+00 0.000E+00 -1.0
204 70140 3.292E-02 0.000E+00 5.625E-03 8.172E-01 0.000E+00 0.000E+00 -1.0
204 80170 0.000E+00 0.000E+00 1.136E-01 0.000E+00 0.000E+00 0.000E+00 -1.0
204 270590 1.033E+01 0.000E+00 9.831E-06 8.784E-05 2.622E+00 0.000E+00 -1.0
204 270600 9.678E-01 0.000E+00 3.872E-06 1.504E-05 0.000E+00 0.000E+00 -1.0
204 270601 2.960E+01 0.000E+00 7.121E-06 1.066E-04 0.000E+00 0.000E+00 -1.0
204 280580 2.013E+00 2.491E-06 1.015E-03 3.166E-03 0.000E+00 0.000E+00 -1.0
204 280590 4.254E+01 0.000E+00 7.310E+00 9.465E-03 0.000E+00 0.000E+00 -1.0
204 280600 1.229E+00 3.471E-06 2.321E-04 1.684E-04 0.000E+00 0.000E+00 -1.0
204 280610 1.108E+00 0.000E+00 4.147E-04 1.558E-04 0.000E+00 0.000E+00 -1.0
204 280620 6.203E+00 0.000E+00 7.228E-06 3.065E-05 0.000E+00 0.000E+00 -1.0
204 280630 1.005E+01 0.000E+00 8.219E-06 1.801E-06 0.000E+00 0.000E+00 -1.0
204 280640 6.583E-01 2.932E-05 4.036E-07 1.629E-07 0.000E+00 0.000E+00 -1.0
204 290630 2.099E+00 0.000E+00 1.415E-05 1.453E-03 0.000E+00 0.000E+00 -1.0
204 300660 3.962E-01 0.000E+00 1.096E-06 3.025E-05 0.000E+00 0.000E+00 -1.0
204 410930 7.226E-01 0.000E+00 3.724E-06 2.285E-05 1.012E-01 0.000E+00 -1.0
204 410940 9.128E+00 0.000E+00 0.000E+00 3.437E-05 0.000E+00 0.000E+00 -1.0
204 420940 3.958E-01 0.000E+00 2.023E-04 3.095E-05 0.000E+00 0.000E+00 -1.0
204 420980 2.326E-01 0.000E+00 2.023E-05 2.450E-06 0.000E+00 0.000E+00 -1.0
204 420990 9.820E-01 7.078E-04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 -1.0
204 430990 1.576E+01 0.000E+00 0.000E+00 8.971E-05 0.000E+00 0.000E+00 -1.0
908 902320 5.243E+00 9.604E-04 7.419E-06 5.603E-03 0.000E+00 0.000E+00 -1.0
908 902330 5.998E+02 4.559E-03 2.103E-05 8.448E+00 0.000E+00 0.000E+00 -1.0
908 912330 3.775E+01 2.756E-04 2.641E-06 3.580E-02 1.234E+01 0.000E+00 -1.0
908 922330 2.352E+01 3.412E-04 9.522E-08 2.427E+02 0.000E+00 0.000E+00 -1.0
908 922340 5.908E+01 9.619E-05 1.088E-06 3.420E-01 0.000E+00 0.000E+00 -1.0

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908	922350	4.446E+01	4.843E-04	3.286E-07	2.475E+02	0.000E+00	0.000E+00	-1.0
908	922360	1.059E+01	5.015E-04	5.369E-06	1.777E-01	0.000E+00	0.000E+00	-1.0
908	922370	2.067E+02	1.455E-03	1.105E-05	1.074E+00	0.000E+00	0.000E+00	-1.0
908	922380	7.963E+00	9.506E-04	4.559E-06	2.344E-02	0.000E+00	0.000E+00	-1.0
908	922390	1.318E+01	4.046E-03	3.036E-05	1.241E+01	0.000E+00	0.000E+00	-1.0
908	922400	5.478E+00	2.084E-03	3.169E-05	1.728E-02	0.000E+00	0.000E+00	-1.0
908	932350	7.673E+02	2.591E-04	3.011E-06	1.787E-01	1.472E+02	0.000E+00	-1.0
908	932360	4.442E+01	7.728E-04	1.706E-06	1.127E+03	0.000E+00	0.000E+00	-1.0
908	932370	9.827E+01	8.859E-05	6.652E-07	1.526E-01	0.000E+00	2.248E-04	-1.0
908	932380	4.442E+01	9.167E-04	3.390E-06	9.323E+02	0.000E+00	0.000E+00	-1.0
908	942370	2.089E+02	3.123E-04	5.974E-07	1.183E+03	0.000E+00	0.000E+00	-1.0
908	942380	2.265E+02	2.748E-04	4.068E-06	7.543E+00	0.000E+00	0.000E+00	-1.0
908	942390	1.653E+02	2.034E-04	2.451E-07	3.807E+02	0.000E+00	0.000E+00	-1.0
908	942400	3.227E+02	9.043E-05	6.963E-07	2.285E-01	0.000E+00	0.000E+00	-1.0
908	942410	1.744E+02	1.315E-03	1.599E-06	4.893E+02	0.000E+00	0.000E+00	-1.0
908	942420	3.823E+01	3.942E-04	2.522E-06	1.225E-01	0.000E+00	0.000E+00	-1.0
908	942430	1.213E+02	3.248E-03	1.860E-05	8.944E+01	0.000E+00	0.000E+00	-1.0
908	952410	3.209E+02	7.424E-05	7.098E-07	1.856E+00	1.084E+01	0.000E+00	-1.0
908	952420	6.614E+02	7.345E-04	3.069E-06	3.252E+03	0.000E+00	0.000E+00	-1.0
908	952430	7.661E+01	4.840E-05	4.381E-07	1.138E-01	5.416E+01	0.000E+00	-1.0
908	962420	1.113E+01	1.123E-05	1.717E-08	1.366E+00	0.000E+00	0.000E+00	-1.0
908	962430	1.632E+02	1.235E-03	3.639E-06	3.125E+02	0.000E+00	0.000E+00	-1.0
908	962440	1.897E+01	2.336E-04	3.570E-06	6.882E-01	0.000E+00	0.000E+00	-1.0
908	962450	1.632E+02	1.289E-03	4.202E-06	8.206E+02	0.000E+00	0.000E+00	-1.0
908	962460	3.911E+00	1.035E-03	9.164E-06	2.483E-01	0.000E+00	0.000E+00	-1.0
908	962470	4.725E+01	1.963E-03	8.476E-06	5.787E+01	0.000E+00	0.000E+00	-1.0
908	962480	8.250E+00	1.138E-03	1.778E-05	5.195E-01	0.000E+00	0.000E+00	-1.0
908	972490	7.832E+02	1.291E-03	1.334E-05	5.230E-01	0.000E+00	0.000E+00	-1.0
908	982490	2.100E+02	1.358E-03	8.820E-06	7.408E+02	0.000E+00	0.000E+00	-1.0
908	982500	1.059E+03	6.726E-04	6.118E-06	3.826E-01	0.000E+00	0.000E+00	-1.0
908	982510	1.272E+03	2.303E-03	9.119E-06	1.556E+03	0.000E+00	0.000E+00	-1.0
908	982520	1.009E+01	5.389E-04	5.416E-06	1.721E+01	0.000E+00	0.000E+00	-1.0
1	10010		0.0000E+00	0	0.0	H1	INPUT BLOCK	
1	10020		0.0000E+00	0	0.0	H2	MASS FOLLOWS	
1	20030		0.0000E+00	0	0.0	He3		
1	20040		0.0000E+00	0	0.0	He4		
1	30060		9.6331E-08	0	0.0	Li6		
1	30070		8.1420E-02	0	0.0	Li7		
1	40090		7.9846E+04	0	0.0	Be9 = balance		
1	40100		0.0000E+00	0	0.0	Be10		
1	50100		2.8762E-02	0	0.0	B10		
1	50110		1.2729E-01	0	0.0	B11		
1	60120		5.9936E+01	0	0.0	C12 C=745ppm		
1	60130		7.2236E-01	0	0.0	C13		
1	70140		1.6657E+01	0	0.0	N14 N=205ppm		
1	70150		6.6280E-02	0	0.0	N15		
1	80160		1.0247E+03	0	0.0	O16		
1	80170		4.3653E-01	0	0.0	O17		
1	80180		2.3110E+00	0	0.0	O18		
1	90190		5.6316E+00	0	0.0	F19		
1	100200		1.0400E+02	0	0.0	Ne20		
1	100210		3.2587E-01	0	0.0	Ne21		
1	100220		1.1696E+01	0	0.0	Ne22		
1	110230		7.1188E-02	0	0.0	Na23		
1	120240		2.8560E+00	0	0.0	Mg24		
1	120250		3.7663E-01	0	0.0	Mg25		
1	120260		4.3126E-01	0	0.0	Mg26		
1	130270		2.8972E+01	0	0.0	Al27		
1	140280		2.3156E+01	0	0.0	Si28		
1	140290		3.0362E+00	0	0.0	Si29		
1	140300		3.4581E+00	0	0.0	Si30		
1	150310		4.0710E+00	0	0.0	P31		
1	160320		5.7857E-01	0	0.0	S32		

1	160330	4.7094E-03	0	0.0	S33
1	160340	2.7236E-02	0	0.0	S34
1	160350	0.0000E+00	0	0.0	S35
1	160360	1.3700E-04	0	0.0	S36
1	170350	3.0425E+00	0	0.0	C135
1	170360	0.0000E+00	0	0.0	C136
1	170370	1.0285E+00	0	0.0	C137
1	180360	1.5736E-03	0	0.0	Ar36
1	180370	0.0000E+00	0	0.0	Ar37
1	180380	3.1052E-04	0	0.0	Ar38
1	180390	0.0000E+00	0	0.0	Ar39
1	180400	5.1676E-01	0	0.0	Ar40
1	190390	9.8900E-01	0	0.0	K39
1	190400	1.2726E-04	0	0.0	K40
1	190410	7.5034E-02	0	0.0	K41
1	200400	1.5740E+01	0	0.0	Ca40
1	200410	0.0000E+00	0	0.0	Ca41
1	200420	1.1031E-01	0	0.0	Ca42
1	200430	2.3564E-02	0	0.0	Ca43
1	200440	3.7258E-01	0	0.0	Ca44
1	200450	0.0000E+00	0	0.0	Ca45
1	200460	7.4690E-04	0	0.0	Ca46
1	200470	0.0000E+00	0	0.0	Ca47
1	200480	3.6436E-02	0	0.0	Ca48
1	210450	1.8727E-01	0	0.0	Sc45
1	220460	3.8550E-01	0	0.0	Ti46
1	220470	3.5941E-01	0	0.0	Ti47
1	220480	3.7108E+00	0	0.0	Ti48
1	220490	2.8231E-01	0	0.0	Ti49
1	220500	2.8284E-01	0	0.0	Ti50
1	230500	6.8319E-04	0	0.0	V50
1	230510	2.7804E-01	0	0.0	V51
1	240500	3.1432E-01	0	0.0	Cr50
1	240510	0.0000E+00	0	0.0	Cr51
1	240520	6.3038E+00	0	0.0	Cr52
1	240530	7.2846E-01	0	0.0	Cr53
1	240540	1.8477E-01	0	0.0	Cr54
1	250550	4.6138E+00	0	0.0	Mn55
1	260540	6.9558E+00	0	0.0	Fe54
1	260550	0.0000E+00	0	0.0	Fe55
1	260560	1.1214E+02	0	0.0	Fe56
1	260570	2.6133E+00	0	0.0	Fe57
1	260580	3.5456E-01	0	0.0	Fe58
1	270590	9.7704E-01	0	0.0	Co59 = 12ppm
1	280580	1.2392E+01	0	0.0	Ni58
1	280590	0.0000E+00	0	0.0	Ni59
1	280600	4.9009E+00	0	0.0	Ni60
1	280610	2.1572E-01	0	0.0	Ni61
1	280620	6.9657E-01	0	0.0	Ni62
1	280630	0.0000E+00	0	0.0	Ni63
1	280640	1.8226E-01	0	0.0	Ni64
1	290630	4.8801E+00	0	0.0	Cu63
1	290640	0.0000E+00	0	0.0	Cu64
1	290650	2.2442E+00	0	0.0	Cu65
1	300640	5.0287E-01	0	0.0	Zn64
1	300650	0.0000E+00	0	0.0	Zn65
1	300660	2.9771E-01	0	0.0	Zn66
1	300670	4.4412E-02	0	0.0	Zn67
1	300680	2.0668E-01	0	0.0	Zn68
1	300690	0.0000E+00	0	0.0	Zn69
1	300700	6.7903E-03	0	0.0	Zn70
1	310690	4.1576E-02	0	0.0	Ga69
1	310700	0.0000E+00	0	0.0	Ga70

1	310710	2.8391E-02	0	0.0	Ga71
1	320700	8.0345E-02	0	0.0	Ge70
1	320710	0.0000E+00	0	0.0	Ge71
1	320720	1.1046E-01	0	0.0	Ge72
1	320730	3.1880E-02	0	0.0	Ge73
1	320740	1.5123E-01	0	0.0	Ge74
1	320750	0.0000E+00	0	0.0	Ge75
1	320760	3.3191E-02	0	0.0	Ge76
1	330750	1.4509E-01	0	0.0	As75
1	340740	1.6347E-03	0	0.0	Se74
1	340750	0.0000E+00	0	0.0	Se75
1	340760	1.6975E-02	0	0.0	Se76
1	340770	1.4364E-02	0	0.0	Se77
1	340780	4.5182E-02	0	0.0	Se78
1	340790	0.0000E+00	0	0.0	Se79
1	340800	9.7983E-02	0	0.0	Se80
1	340810	0.0000E+00	0	0.0	Se81
1	340820	1.7913E-02	0	0.0	Se82
1	350790	2.1197E+00	0	0.0	Br79
1	350800	0.0000E+00	0	0.0	Br80
1	350810	2.1142E+00	0	0.0	Br81
1	360780	2.2566E-02	0	0.0	Kr78
1	360790	0.0000E+00	0	0.0	Kr79
1	360800	1.4879E-01	0	0.0	Kr80
1	360810	0.0000E+00	0	0.0	Kr81
1	360820	7.8627E-01	0	0.0	Kr82
1	360830	7.8900E-01	0	0.0	Kr83
1	360840	3.9578E+00	0	0.0	Kr84
1	360850	0.0000E+00	0	0.0	Kr85
1	360860	1.2298E+00	0	0.0	Kr86
1	370850	4.5334E-01	0	0.0	Rb85
1	370860	0.0000E+00	0	0.0	Rb86
1	370870	1.7902E-01	0	0.0	Rb87
1	380840	2.6200E-03	0	0.0	Sr84
1	380850	0.0000E+00	0	0.0	Sr85
1	380860	4.7229E-02	0	0.0	Sr86
1	380870	3.3919E-02	0	0.0	Sr87
1	380880	4.0475E-01	0	0.0	Sr88
1	390890	8.1420E-02	0	0.0	Y89
1	400900	1.5777E+00	0	0.0	Zr90
1	400910	3.4788E-01	0	0.0	Zr91
1	400920	5.3759E-01	0	0.0	Zr92
1	400930	0.0000E+00	0	0.0	Zr93
1	400940	5.5664E-01	0	0.0	Zr94
1	400950	0.0000E+00	0	0.0	Zr95
1	400960	9.1586E-02	0	0.0	Zr96
1	410930	9.5261E-01	0	0.0	Nb93
1	420920	1.1576E-01	0	0.0	Mo92
1	420930	0.0000E+00	0	0.0	Mo93
1	420940	7.3725E-02	0	0.0	Mo94
1	420950	1.2824E-01	0	0.0	Mo95
1	420960	1.3577E-01	0	0.0	Mo96
1	420970	7.8545E-02	0	0.0	Mo97
1	420980	2.0051E-01	0	0.0	Mo98
1	420990	0.0000E+00	0	0.0	Mo99
1	421000	8.1653E-02	0	0.0	Mo100
1	430990	0.0000E+00	0	0.0	Tc99
1	440960	2.1403E-02	0	0.0	Ru96
1	440970	0.0000E+00	0	0.0	Ru97
1	440980	7.3354E-03	0	0.0	Ru98
1	440990	5.0597E-02	0	0.0	Ru99
1	441000	5.0706E-02	0	0.0	Ru100
1	441010	6.9503E-02	0	0.0	Ru101

1	441020	1.2971E-01	0	0.0	Ru102
1	441030	0.0000E+00	0	0.0	Ru103
1	441040	7.7845E-02	0	0.0	Ru104
1	451030	8.0904E-02	0	0.0	Rh103
1	461020	3.9766E-03	0	0.0	Pd102
1	461030	0.0000E+00	0	0.0	Pd103
1	461040	4.4282E-02	0	0.0	Pd104
1	461050	8.9616E-02	0	0.0	Pd105
1	461060	1.1073E-01	0	0.0	Pd106
1	461070	0.0000E+00	0	0.0	Pd107
1	461080	1.0922E-01	0	0.0	Pd108
1	461090	0.0000E+00	0	0.0	Pd109
1	461100	4.9275E-02	0	0.0	Pd110
1	471070	9.0633E-02	0	0.0	Ag107
1	471080	0.0000E+00	0	0.0	Ag108
1	471090	8.5777E-02	0	0.0	Ag109
1	481060	9.5888E-04	0	0.0	Cd106
1	481070	0.0000E+00	0	0.0	Cd107
1	481080	6.9560E-04	0	0.0	Cd108
1	481090	0.0000E+00	0	0.0	Cd109
1	481100	9.9427E-03	0	0.0	Cd110
1	481110	1.0282E-02	0	0.0	Cd111
1	481120	1.9558E-02	0	0.0	Cd112
1	481130	9.9930E-03	0	0.0	Cd113
1	481140	2.3702E-02	0	0.0	Cd114
1	481150	0.0000E+00	0	0.0	Cd115
1	481160	6.2876E-03	0	0.0	Cd116
1	491130	2.3594E-04	0	0.0	In113
1	491140	0.0000E+00	0	0.0	In114
1	491150	5.3440E-03	0	0.0	In115
1	501120	2.2336E-03	0	0.0	Sn112
1	501130	0.0000E+00	0	0.0	Sn113
1	501140	1.5234E-03	0	0.0	Sn114
1	501150	8.5115E-04	0	0.0	Sn115
1	501160	3.4652E-02	0	0.0	Sn116
1	501170	1.8474E-02	0	0.0	Sn117
1	501180	5.8758E-02	0	0.0	Sn118
1	501190	2.0991E-02	0	0.0	Sn119
1	501200	8.0403E-02	0	0.0	Sn120
1	501210	0.0000E+00	0	0.0	Sn121
1	501220	1.1613E-02	0	0.0	Sn122
1	501230	0.0000E+00	0	0.0	Sn123
1	501240	1.4761E-02	0	0.0	Sn124
1	511210	1.1169E-02	0	0.0	Sb121
1	511220	0.0000E+00	0	0.0	Sb122
1	511230	8.4261E-03	0	0.0	Sb123
1	521200	3.4505E-03	0	0.0	Te120
1	521210	0.0000E+00	0	0.0	Te121
1	521220	9.5640E-02	0	0.0	Te122
1	521230	3.3692E-02	0	0.0	Te123
1	521240	1.7978E-01	0	0.0	Te124
1	521250	2.6938E-01	0	0.0	Te125
1	521260	7.2194E-01	0	0.0	Te126
1	521270	0.0000E+00	0	0.0	Te127
1	521280	1.2281E+00	0	0.0	Te128
1	521290	0.0000E+00	0	0.0	Te129
1	521300	1.3327E+00	0	0.0	Te130
1	531270	8.1420E-01	0	0.0	I127
1	541240	4.1290E-02	0	0.0	Xe124
1	541250	0.0000E+00	0	0.0	Xe125
1	541260	3.7760E-02	0	0.0	Xe126
1	541270	0.0000E+00	0	0.0	Xe127
1	541280	8.1407E-01	0	0.0	Xe128

1	541290	1.1340E+01	0	0.0	Xe129
1	541300	1.7748E+00	0	0.0	Xe130
1	541310	9.2475E+00	0	0.0	Xe131
1	541320	1.1823E+01	0	0.0	Xe132
1	541330	0.0000E+00	0	0.0	Xe133
1	541340	4.6404E+00	0	0.0	Xe134
1	541350	0.0000E+00	0	0.0	Xe135
1	541360	4.0304E+00	0	0.0	Xe136
1	551330	1.6393E-02	0	0.0	Cs133 = 0.20ppm
1	561300	4.8987E-04	0	0.0	Ba130
1	561310	0.0000E+00	0	0.0	Ba131
1	561320	4.7394E-04	0	0.0	Ba132
1	561330	0.0000E+00	0	0.0	Ba133
1	561340	1.1528E-02	0	0.0	Ba134
1	561350	3.1641E-02	0	0.0	Ba135
1	561360	3.7952E-02	0	0.0	Ba136
1	561370	5.4692E-02	0	0.0	Ba137
1	561380	3.5174E-01	0	0.0	Ba138
1	571380	7.2751E-05	0	0.0	La138
1	571390	8.1347E-02	0	0.0	La139
1	581360	1.5005E-04	0	0.0	Ce136
1	581370	0.0000E+00	0	0.0	Ce137
1	581380	2.0034E-04	0	0.0	Ce138
1	581390	0.0000E+00	0	0.0	Ce139
1	581400	7.1892E-02	0	0.0	Ce140
1	581410	0.0000E+00	0	0.0	Ce141
1	581420	9.1780E-03	0	0.0	Ce142
1	591410	8.1420E-02	0	0.0	Pr141
1	601420	1.0866E-01	0	0.0	Nd142
1	601430	4.9127E-02	0	0.0	Nd143
1	601440	9.6667E-02	0	0.0	Nd144
1	601450	3.3946E-02	0	0.0	Nd145
1	601460	7.0790E-02	0	0.0	Nd146
1	601470	0.0000E+00	0	0.0	Nd147
1	601480	2.4045E-02	0	0.0	Nd148
1	601490	0.0000E+00	0	0.0	Nd149
1	601500	2.3862E-02	0	0.0	Nd150
1	611450	0.0000E+00	0	0.0	Pm145
1	621440	1.2080E-03	0	0.0	Sm144
1	621450	0.0000E+00	0	0.0	Sm145
1	621460	0.0000E+00	0	0.0	Sm146
1	621470	5.9668E-03	0	0.0	Sm147
1	621480	4.5256E-03	0	0.0	Sm148
1	621490	5.5641E-03	0	0.0	Sm149
1	621500	3.0037E-03	0	0.0	Sm150
1	621510	0.0000E+00	0	0.0	Sm151
1	621520	1.0982E-02	0	0.0	Sm152
1	621530	0.0000E+00	0	0.0	Sm153
1	621540	9.4597E-03	0	0.0	Sm154
1	631510	0.0	0	0.0	Eu151=0
1	631520	0.0000E+00	0	0.0	Eu152=0
1	631530	0.0	0	0.0	Eu153=0
1	641520	3.1465E-05	0	0.0	Gd152
1	641530	0.0000E+00	0	0.0	Gd153
1	641540	3.4748E-04	0	0.0	Gd154
1	641550	2.3744E-03	0	0.0	Gd155
1	641560	3.3052E-03	0	0.0	Gd156
1	641570	2.5431E-03	0	0.0	Gd157
1	641580	4.0622E-03	0	0.0	Gd158
1	641590	0.0000E+00	0	0.0	Gd159
1	641600	3.6201E-03	0	0.0	Gd160
1	651590	8.1420E-02	0	0.0	Tb159
1	661560	9.3756E-06	0	0.0	Dy156

1	661570	0.0000E+00	0	0.0	Dy157
1	661580	1.5826E-05	0	0.0	Dy158
1	661590	0.0000E+00	0	0.0	Dy159
1	661600	3.7502E-04	0	0.0	Dy160
1	661610	3.0480E-03	0	0.0	Dy161
1	661620	4.1379E-03	0	0.0	Dy162
1	661630	4.0655E-03	0	0.0	Dy163
1	661640	4.6325E-03	0	0.0	Dy164
1	671650	8.1420E-02	0	0.0	Ho165
1	681620	5.5181E-05	0	0.0	Er162
1	681630	0.0000E+00	0	0.0	Er163
1	681640	6.4241E-04	0	0.0	Er164
1	681650	0.0000E+00	0	0.0	Er165
1	681660	1.3570E-02	0	0.0	Er166
1	681670	9.3249E-03	0	0.0	Er167
1	681680	1.0954E-02	0	0.0	Er168
1	681690	0.0000E+00	0	0.0	Er169
1	681700	6.1628E-03	0	0.0	Er170
1	691690	4.0710E-02	0	0.0	Tm169
1	701680	2.0546E-05	0	0.0	Yb168
1	701690	0.0000E+00	0	0.0	Yb169
1	701700	4.8778E-04	0	0.0	Yb170
1	701710	2.3004E-03	0	0.0	Yb171
1	701720	3.5436E-03	0	0.0	Yb172
1	701730	2.6235E-03	0	0.0	Yb173
1	701740	5.2054E-03	0	0.0	Yb174
1	701750	0.0000E+00	0	0.0	Yb175
1	701760	2.1028E-03	0	0.0	Yb176
1	711750	5.2866E-02	0	0.0	Lu175
1	711760	1.4137E-03	0	0.0	Lu176
1	721740	5.4417E-05	0	0.0	Hf174
1	721750	0.0000E+00	0	0.0	Hf175
1	721760	1.7688E-03	0	0.0	Hf176
1	721770	6.3577E-03	0	0.0	Hf177
1	721780	9.3801E-03	0	0.0	Hf178
1	721790	4.7097E-03	0	0.0	Hf179
1	721800	1.2197E-02	0	0.0	Hf180
1	731801	4.2072E-06	0	0.0	Ta180M
1	731810	3.5251E-02	0	0.0	Ta181
1	741800	7.2886E-03	0	0.0	W180
1	741810	0.0000E+00	0	0.0	W181
1	741820	1.6152E+00	0	0.0	W182
1	741830	8.8179E-01	0	0.0	W183
1	741840	1.9061E+00	0	0.0	W184
1	741850	0.0000E+00	0	0.0	W185
1	741860	1.7950E+00	0	0.0	W186
1	751850	1.9479E-02	0	0.0	Re185
1	751860	0.0000E+00	0	0.0	Re186
1	751870	3.2956E-02	0	0.0	Re187
1	761840	1.0031E-05	0	0.0	Os184
1	761850	0.0000E+00	0	0.0	Os185
1	761860	8.0102E-04	0	0.0	Os186
1	761870	8.1553E-04	0	0.0	Os187
1	761880	6.8153E-03	0	0.0	Os188
1	761890	8.2940E-03	0	0.0	Os189
1	761900	1.3672E-02	0	0.0	Os190
1	761910	0.0000E+00	0	0.0	Os191
1	761920	2.1457E-02	0	0.0	Os192
1	771910	1.5086E-04	0	0.0	Ir191
1	771920	0.0000E+00	0	0.0	Ir192
1	771930	2.5624E-04	0	0.0	Ir193
1	781900	8.0765E-04	0	0.0	Pt190
1	781910	0.0000E+00	0	0.0	Pt191

1	781920	6.4476E-02	0	0.0	Pt192
1	781930	0.0000E+00	0	0.0	Pt193
1	781940	2.7131E+00	0	0.0	Pt194
1	781950	2.8017E+00	0	0.0	Pt195
1	781960	2.1079E+00	0	0.0	Pt196
1	781970	0.0000E+00	0	0.0	Pt197
1	781980	6.0600E-01	0	0.0	Pt198
1	791970	2.0192E+00	0	0.0	Au197
1	801960	4.8596E-04	0	0.0	Hg196
1	801970	0.0000E+00	0	0.0	Hg197
1	801980	3.2728E-02	0	0.0	Hg198
1	801990	5.5590E-02	0	0.0	Hg199
1	802000	7.6366E-02	0	0.0	Hg200
1	802010	4.3856E-02	0	0.0	Hg201
1	802020	9.9500E-02	0	0.0	Hg202
1	802030	0.0000E+00	0	0.0	Hg203
1	802040	2.3098E-02	0	0.0	Hg204
1	812030	5.9674E-01	0	0.0	Tl203
1	812040	0.0000E+00	0	0.0	Tl204
1	812050	1.4388E+00	0	0.0	Tl205
1	822040	1.1221E-03	0	0.0	Pb204
1	822050	0.0000E+00	0	0.0	Pb205
1	822060	1.9505E-02	0	0.0	Pb206
1	822070	1.7973E-02	0	0.0	Pb207
1	822080	4.2820E-02	0	0.0	Pb208
1	832090	0.0000E+00	0	0.0	Bi209
2	902320	3.5662E-02	0	0.0	Th232
2	922340	1.3210E-04	0	0.0	U234
2	922350	1.7367E-02	0	0.0	U235
2	922360	0.0000E+00	0	0.0	U236
2	922370	0.0000E+00	0	0.0	U237
2	922380	2.4251E+00	0	0.0	U238 U=30ppm
0					

Appendix E

**Oak Ridge Isotope GENeration and Depletion Code Version 2
Input Model for the Materials Test Reactor
Beryllium Reflector from Core 1**

Appendix E

Oak Ridge Isotope GENeration and Depletion Code Version 2 Input Model for the Materials Test Reactor Beryllium Reflector from Core 1

Appendix E is a listing of the input file used with the Oak Ridge Isotope GENeration and Depletion Code Version 2 to model activation and transmutation in the beryllium reflector used for Core 1 of the Materials Test Reactor.

```
-1
-1
-1
TIT MMTR - Beryllium Block Inventory (CURIES) Revised 1/31/2003
TIT IINPUT: BE_MTR3.inp ACTIVATION ANALYSIS
TIT OOUTPUT: BE_MTR3.out INCLUDES NEW XS SET
TIT
TIT CCOMPONENT: Total MTR Beryllium Block Inventory
TIT LLOCATION: MTR BLOCKS for 2,000 kg
TIT IIRARADIATION: 3/31/52 - 7/3/69 for 6,303 days
TIT
TIT MMATERIAL: Beryllium Metal
TIT MMATERIAL MASS: 2.0E+6 grams of Be including other trace elements
BAS
LIP 0 0 0
LPU 30060 40090
      60120 60130 70140 80170 270590
      270600 270601 280580 280590 280600
      280610 280620 280630 280640 290630
      300660 410930 410940 420940 420980
      420990 430990           -1
LPU 902320 902330 912330 922330 922340
      922350 922360 922370 922380 922390
      922400 932350 932360 932370 932380
      942370 942380 942390 942400 942410
      942420 942430 952410 952420 952430
      962420 962430 962440 962450 962460
      962470 962480 972490 982490 982500
      982510 982520           -1
LIB 0 1 2 3 -204 -908 909 9 50 0 4 0
PHO 101 102 103 10
RDA -----
RDA * All Beryllium Blocks for MTR
RDA * 1952-1969 (or 6,303-day irradiation from March 3, 1952=19,084)
RDA * Decay Time: 0 days = Scram on July 3, 1969
RDA * Decay Time: 6,303+2,920 = 9,224 days=July 2, 1977 est disposal date
RDA * Decay Time: 6,303+11,762 = 18,065 days = Sept 15, 2001
RDA -----
OPTL 8 8 8 8 2 8 2 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OPTA 8 8 8 8 2 8 2 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OPTF 8 8 8 8 2 8 2 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
CUT    7 1.0E-06          28 1.0E-75   -1
INP -1 1 -1 -1 1           Read input to vector -1
MOV -1 1 0 1.0            Input of Be at 2.0E6 g
BUP
RDA Est total flux to power ratio in the MTR reflector is 1.0E14/40 MW
RDA MTR total exposure = 177,887 MWD over 6,303 D => 28.22 MW per day
IRF 500.0     7.056E+13  1 2 4 2 at 28.22 MW
IRF 1000.0    7.056E+13  2 3 4 0 at 28.22 MW
```

IRF 1500.0 7.056E+13 3 4 4 0 at 28.22 MW
 IRF 2000.0 7.056E+13 4 5 4 0 at 28.22 MW
 IRF 2500.0 7.056E+13 5 6 4 0 at 28.22 MW
 IRF 3000.0 7.056E+13 6 7 4 0 at 28.22 MW
 IRF 3500.0 7.056E+13 7 8 4 0 at 28.22 MW
 IRF 4000.0 7.056E+13 8 9 4 0 at 28.22 MW
 IRF 4500.0 7.056E+13 9 10 4 0 at 28.22 MW
 IRF 5000.0 7.056E+13 10 11 4 0 at 28.22 MW
 IRF 5500.0 7.056E+13 11 12 4 0 at 28.22 MW
 MOV 12 2 0 1.0
 IRF 6000.0 7.056E+13 2 3 4 0 at 28.22 MW
 MOV 3 2 0 1.0
 IRF 6303.0 7.056E+13 2 3 4 0 End of irradiation 7/3/1969
 DEC 9224.0 3 4 4 0 Est disposal date July 1977
 DEC 18065.0 4 5 4 0 to date Sept 15, 2001
 HED 3 JUL1969
 HED 4 JUL1977
 HED 5 SEP2001
 OUT 5 1 0 0
 STP 4
 204 30060 8.483E-03 0.000E+00 2.063E+02 7.452E-04 0.000E+00 0.000E+00 -1.0
 204 40090 1.948E-03 2.080E-02 7.427E-03 0.000E+00 0.000E+00 0.000E+00 -1.0
 204 60120 1.142E-03 0.000E+00 1.003E-04 0.000E+00 0.000E+00 0.000E+00 -1.0
 204 60130 2.060E-04 4.540E-05 7.969E-04 0.000E+00 0.000E+00 0.000E+00 -1.0
 204 70140 1.660E-02 0.000E+00 1.692E-02 4.195E-01 0.000E+00 0.000E+00 -1.0
 204 80170 0.000E+00 0.000E+00 7.786E-02 0.000E+00 0.000E+00 0.000E+00 -1.0
 204 270590 5.743E+00 0.000E+00 2.786E-05 2.632E-04 2.622E+00 0.000E+00 -1.0
 204 270600 5.549E-01 0.000E+00 1.108E-05 4.447E-05 0.000E+00 0.000E+00 -1.0
 204 270601 1.767E+01 0.000E+00 2.068E-05 3.162E-04 0.000E+00 0.000E+00 -1.0
 204 280580 1.018E+00 2.491E-06 3.127E-03 9.706E-03 0.000E+00 0.000E+00 -1.0
 204 280590 2.296E+01 0.000E+00 4.436E+00 2.112E-02 0.000E+00 0.000E+00 -1.0
 204 280600 6.251E-01 2.200E-06 6.871E-04 5.211E-04 0.000E+00 0.000E+00 -1.0
 204 280610 5.730E-01 0.000E+00 1.262E-03 4.781E-04 0.000E+00 0.000E+00 -1.0
 204 280620 3.129E+00 0.000E+00 2.113E-05 3.065E-05 0.000E+00 0.000E+00 -1.0
 204 280630 5.072E+00 0.000E+00 2.415E-05 5.060E-06 0.000E+00 0.000E+00 -1.0
 204 280640 3.377E-01 4.075E-05 1.010E-06 2.838E-07 0.000E+00 0.000E+00 -1.0
 204 290630 1.109E+00 0.000E+00 4.053E-05 4.417E-03 0.000E+00 0.000E+00 -1.0
 204 300660 2.151E-01 0.000E+00 2.641E-06 8.900E-05 0.000E+00 0.000E+00 -1.0
 204 410930 5.213E-01 0.000E+00 1.057E-05 6.672E-05 1.012E-01 0.000E+00 -1.0
 204 410940 6.651E+00 0.000E+00 0.000E+00 1.006E-04 0.000E+00 0.000E+00 -1.0
 204 420940 2.676E-01 0.000E+00 2.023E-04 8.577E-05 0.000E+00 0.000E+00 -1.0
 204 420980 2.359E-01 0.000E+00 2.023E-05 2.450E-06 0.000E+00 0.000E+00 -1.0
 204 420990 8.793E-01 2.085E-03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 -1.0
 204 430990 1.254E+01 0.000E+00 0.000E+00 2.643E-04 0.000E+00 0.000E+00 -1.0
 908 902320 4.053E+00 2.847E-03 3.904E-06 1.560E-02 0.000E+00 0.000E+00 -1.0
 908 902330 2.970E+02 1.326E-02 2.515E-05 5.525E+00 0.000E+00 0.000E+00 -1.0
 908 912330 3.147E+01 8.192E-04 1.223E-07 9.902E-02 1.234E+01 0.000E+00 -1.0
 908 922330 1.375E+01 9.849E-04 0.000E+00 1.309E+02 0.000E+00 0.000E+00 -1.0
 908 922340 3.774E+01 2.681E-04 5.126E-08 4.346E-01 0.000E+00 0.000E+00 -1.0
 908 922350 2.396E+01 1.416E-03 7.930E-08 1.248E+02 0.000E+00 0.000E+00 -1.0
 908 922360 1.078E+01 1.509E-03 2.759E-06 2.655E-01 0.000E+00 0.000E+00 -1.0
 908 922370 1.055E+02 4.314E-03 1.097E-05 8.004E-01 0.000E+00 0.000E+00 -1.0
 908 922380 8.514E+00 2.830E-03 2.124E-06 6.451E-02 0.000E+00 0.000E+00 -1.0
 908 922390 8.960E+00 1.181E-02 4.250E-05 1.042E+01 0.000E+00 0.000E+00 -1.0
 908 922400 5.799E+00 6.156E-03 4.681E-05 4.871E-02 0.000E+00 0.000E+00 -1.0
 908 932350 3.759E+02 7.520E-04 0.000E+00 3.793E-01 1.472E+02 0.000E+00 -1.0
 908 932360 2.266E+01 2.270E-03 1.285E-07 5.810E+02 0.000E+00 0.000E+00 -1.0
 908 932370 6.185E+01 2.586E-04 4.320E-08 3.535E-01 0.000E+00 2.248E-04 -1.0
 908 932380 2.266E+01 2.674E-03 1.030E-06 4.804E+02 0.000E+00 0.000E+00 -1.0
 908 942370 1.259E+02 9.328E-04 0.000E+00 6.586E+02 0.000E+00 0.000E+00 -1.0
 908 942380 1.108E+02 7.726E-04 1.072E-07 4.462E+00 0.000E+00 0.000E+00 -1.0
 908 942390 1.001E+02 5.948E-04 1.280E-08 2.129E+02 0.000E+00 0.000E+00 -1.0
 908 942400 2.870E+02 2.639E-04 1.820E-07 4.323E-01 0.000E+00 0.000E+00 -1.0

908	942410	9.347E+01	3.833E-03	1.294E-06	2.598E+02	0.000E+00	0.000E+00	-1.0
908	942420	3.533E+01	1.170E-03	6.160E-07	2.934E-01	0.000E+00	0.000E+00	-1.0
908	942430	6.342E+01	9.415E-03	2.205E-05	5.155E+01	0.000E+00	0.000E+00	-1.0
908	952410	1.967E+02	2.155E-04	1.014E-07	1.395E+00	1.084E+01	0.000E+00	-1.0
908	952420	3.336E+02	2.167E-03	1.333E-06	1.647E+03	0.000E+00	0.000E+00	-1.0
908	952430	6.742E+01	1.385E-04	2.613E-08	2.855E-01	5.416E+01	0.000E+00	-1.0
908	962420	8.458E+00	3.412E-05	0.000E+00	8.529E-01	0.000E+00	0.000E+00	-1.0
908	962430	8.037E+01	3.600E-03	1.135E-06	1.650E+02	0.000E+00	0.000E+00	-1.0
908	962440	2.037E+01	6.956E-04	7.324E-07	8.641E-01	0.000E+00	0.000E+00	-1.0
908	962450	8.037E+01	3.754E-03	1.740E-06	4.055E+02	0.000E+00	0.000E+00	-1.0
908	962460	4.296E+00	3.117E-03	8.592E-06	4.185E-01	0.000E+00	0.000E+00	-1.0
908	962470	2.862E+01	5.672E-03	9.587E-06	4.261E+01	0.000E+00	0.000E+00	-1.0
908	962480	8.549E+00	3.385E-03	2.084E-05	6.770E-01	0.000E+00	0.000E+00	-1.0
908	972490	4.474E+02	3.844E-03	1.072E-05	4.325E-01	0.000E+00	0.000E+00	-1.0
908	982490	1.066E+02	3.958E-03	9.771E-06	3.958E+02	0.000E+00	0.000E+00	-1.0
908	982500	7.566E+02	2.041E-03	4.272E-06	7.161E-01	0.000E+00	0.000E+00	-1.0
908	982510	6.595E+02	6.666E-03	1.017E-05	7.864E+02	0.000E+00	0.000E+00	-1.0
908	982520	5.804E+00	1.587E-03	7.279E-06	1.057E+01	0.000E+00	0.000E+00	-1.0
1	10010	0.0000	0	0.0	H1			
1	10020	0.0000	0	0.0	H2			
1	20030	0.0000	0	0.0	He3			
1	20040	0.0000	0	0.0	He4			
1	30060	0.0000	0	0.0	Li6			
1	30070	2.0000	0	0.0	Li7			
1	40090	1961335.6700	0	0.0	Be9			
1	40100	0.0000	0	0.0	Be10			
1	50100	0.7065	0	0.0	B10			
1	50110	3.1268	0	0.0	B11			
1	60120	1472.2559	0	0.0	C12			
1	60130	17.7441	0	0.0	C13			
1	70140	409.1719	0	0.0	N14			
1	70150	1.6281	0	0.0	N15			
1	80160	25169.8420	0	0.0	O16			
1	80170	10.7229	0	0.0	O17			
1	80180	56.7684	0	0.0	O18			
1	90190	138.3333	0	0.0	F19			
1	100200	2554.7041	0	0.0	Ne20			
1	100210	8.0046	0	0.0	Ne21			
1	100220	287.2913	0	0.0	Ne22			
1	110230	1.7487	0	0.0	Na23			
1	120240	70.1550	0	0.0	Mg24			
1	120250	9.2516	0	0.0	Mg25			
1	120260	10.5934	0	0.0	Mg26			
1	130270	711.6667	0	0.0	Al27			
1	140280	568.8058	0	0.0	Si28			
1	140290	74.5816	0	0.0	Si29			
1	140300	84.9459	0	0.0	Si30			
1	150310	100.0000	0	0.0	P31			
1	160320	14.2119	0	0.0	S32			
1	160330	0.1157	0	0.0	S33			
1	160340	0.6690	0	0.0	S34			
1	160350	0.0000	0	0.0	S35			
1	160360	0.0034	0	0.0	S36			
1	170350	74.7352	0	0.0	C135			
1	170360	0.0000	0	0.0	C136			
1	170370	25.2648	0	0.0	C137			
1	180360	0.0387	0	0.0	Ar36			
1	180370	0.0000	0	0.0	Ar37			
1	180380	0.0076	0	0.0	Ar38			
1	180390	0.0000	0	0.0	Ar39			
1	180400	12.6937	0	0.0	Ar40			
1	190390	24.2937	0	0.0	K39			
1	190400	0.0031	0	0.0	K40			

1	190410	1.8431	0	0.0	K41
1	200400	386.6463	0	0.0	Ca40
1	200410	0.0000	0	0.0	Ca41
1	200420	2.7096	0	0.0	Ca42
1	200430	0.5788	0	0.0	Ca43
1	200440	9.1519	0	0.0	Ca44
1	200450	0.0000	0	0.0	Ca45
1	200460	0.0183	0	0.0	Ca46
1	200470	0.0000	0	0.0	Ca47
1	200480	0.8950	0	0.0	Ca48
1	210450	4.6000	0	0.0	Sc45
1	220460	9.4694	0	0.0	Ti46
1	220470	8.8286	0	0.0	Ti47
1	220480	91.1529	0	0.0	Ti48
1	220490	6.9348	0	0.0	Ti49
1	220500	6.9476	0	0.0	Ti50
1	230500	0.0168	0	0.0	V50
1	230510	6.8299	0	0.0	V51
1	240500	7.7209	0	0.0	Cr50
1	240510	0.0000	0	0.0	Cr51
1	240520	154.8465	0	0.0	Cr52
1	240530	17.8939	0	0.0	Cr53
1	240540	4.5387	0	0.0	Cr54
1	250550	113.3333	0	0.0	Mn55
1	260540	170.8626	0	0.0	Fe54
1	260550	0.0000	0	0.0	Fe55
1	260560	2754.5672	0	0.0	Fe56
1	260570	64.1941	0	0.0	Fe57
1	260580	8.7094	0	0.0	Fe58
1	270590	24.0000	0	0.0	Co59
1	280580	304.3952	0	0.0	Ni58
1	280590	0.0000	0	0.0	Ni59
1	280600	120.3848	0	0.0	Ni60
1	280610	5.2989	0	0.0	Ni61
1	280620	17.1106	0	0.0	Ni62
1	280630	0.0000	0	0.0	Ni63
1	280640	4.4771	0	0.0	Ni64
1	290630	119.8743	0	0.0	Cu63
1	290640	0.0000	0	0.0	Cu64
1	290650	55.1257	0	0.0	Cu65
1	300640	12.3525	0	0.0	Zn64
1	300650	0.0000	0	0.0	Zn65
1	300660	7.3128	0	0.0	Zn66
1	300670	1.0909	0	0.0	Zn67
1	300680	5.0770	0	0.0	Zn68
1	300690	0.0000	0	0.0	Zn69
1	300700	0.1668	0	0.0	Zn70
1	310690	1.0213	0	0.0	Ga69
1	310700	0.0000	0	0.0	Ga70
1	310710	0.6974	0	0.0	Ga71
1	320700	1.9736	0	0.0	Ge70
1	320710	0.0000	0	0.0	Ge71
1	320720	2.7132	0	0.0	Ge72
1	320730	0.7831	0	0.0	Ge73
1	320740	3.7148	0	0.0	Ge74
1	320750	0.0000	0	0.0	Ge75
1	320760	0.8153	0	0.0	Ge76
1	330750	3.5640	0	0.0	As75
1	340740	0.0402	0	0.0	Se74
1	340750	0.0000	0	0.0	Se75
1	340760	0.4170	0	0.0	Se76
1	340770	0.3528	0	0.0	Se77
1	340780	1.1099	0	0.0	Se78

1	340790	0.0000	0	0.0	Se79
1	340800	2.4068	0	0.0	Se80
1	340810	0.0000	0	0.0	Se81
1	340820	0.4400	0	0.0	Se82
1	350790	52.0676	0	0.0	Br79
1	350800	0.0000	0	0.0	Br80
1	350810	51.9324	0	0.0	Br81
1	360780	0.5543	0	0.0	Kr78
1	360790	0.0000	0	0.0	Kr79
1	360800	3.6549	0	0.0	Kr80
1	360810	0.0000	0	0.0	Kr81
1	360820	19.3140	0	0.0	Kr82
1	360830	19.3810	0	0.0	Kr83
1	360840	97.2196	0	0.0	Kr84
1	360850	0.0000	0	0.0	Kr85
1	360860	30.2096	0	0.0	Kr86
1	370850	11.1359	0	0.0	Rb85
1	370860	0.0000	0	0.0	Rb86
1	370870	4.3974	0	0.0	Rb87
1	380840	0.0644	0	0.0	Sr84
1	380850	0.0000	0	0.0	Sr85
1	380860	1.1601	0	0.0	Sr86
1	380870	0.8332	0	0.0	Sr87
1	380880	9.9423	0	0.0	Sr88
1	390890	2.0000	0	0.0	Y89
1	400900	38.7548	0	0.0	Zr90
1	400910	8.5454	0	0.0	Zr91
1	400920	13.2053	0	0.0	Zr92
1	400930	0.0000	0	0.0	Zr93
1	400940	13.6734	0	0.0	Zr94
1	400950	0.0000	0	0.0	Zr95
1	400960	2.2497	0	0.0	Zr96
1	410930	23.4000	0	0.0	Nb93
1	420920	2.8436	0	0.0	Mo92
1	420930	0.0000	0	0.0	Mo93
1	420940	1.8110	0	0.0	Mo94
1	420950	3.1500	0	0.0	Mo95
1	420960	3.3351	0	0.0	Mo96
1	420970	1.9294	0	0.0	Mo97
1	420980	4.9252	0	0.0	Mo98
1	420990	0.0000	0	0.0	Mo99
1	421000	2.0057	0	0.0	Mo100
1	430990	0.0000	0	0.0	Tc99
1	440960	0.5257	0	0.0	Ru96
1	440970	0.0000	0	0.0	Ru97
1	440980	0.1802	0	0.0	Ru98
1	440990	1.2429	0	0.0	Ru99
1	441000	1.2455	0	0.0	Ru100
1	441010	1.7073	0	0.0	Ru101
1	441020	3.1862	0	0.0	Ru102
1	441030	0.0000	0	0.0	Ru103
1	441040	1.9122	0	0.0	Ru104
1	451030	1.9873	0	0.0	Rh103
1	461020	0.0977	0	0.0	Pd102
1	461030	0.0000	0	0.0	Pd103
1	461040	1.0877	0	0.0	Pd104
1	461050	2.2013	0	0.0	Pd105
1	461060	2.7199	0	0.0	Pd106
1	461070	0.0000	0	0.0	Pd107
1	461080	2.6830	0	0.0	Pd108
1	461090	0.0000	0	0.0	Pd109
1	461100	1.2104	0	0.0	Pd110
1	471070	2.2263	0	0.0	Ag107

1	471080	0.0000	0	0.0	Ag108
1	471090	2.1070	0	0.0	Ag109
1	481060	0.0236	0	0.0	Cd106
1	481070	0.0000	0	0.0	Cd107
1	481080	0.0171	0	0.0	Cd108
1	481090	0.0000	0	0.0	Cd109
1	481100	0.2442	0	0.0	Cd110
1	481110	0.2526	0	0.0	Cd111
1	481120	0.4804	0	0.0	Cd112
1	481130	0.2455	0	0.0	Cd113
1	481140	0.5822	0	0.0	Cd114
1	481150	0.0000	0	0.0	Cd115
1	481160	0.1544	0	0.0	Cd116
1	491130	0.0058	0	0.0	In113
1	491140	0.0000	0	0.0	In114
1	491150	0.1313	0	0.0	In115
1	501120	0.0549	0	0.0	Sn112
1	501130	0.0000	0	0.0	Sn113
1	501140	0.0374	0	0.0	Sn114
1	501150	0.0209	0	0.0	Sn115
1	501160	0.8512	0	0.0	Sn116
1	501170	0.4538	0	0.0	Sn117
1	501180	1.4433	0	0.0	Sn118
1	501190	0.5156	0	0.0	Sn119
1	501200	1.9750	0	0.0	Sn120
1	501210	0.0000	0	0.0	Sn121
1	501220	0.2853	0	0.0	Sn122
1	501230	0.0000	0	0.0	Sn123
1	501240	0.3626	0	0.0	Sn124
1	511210	0.2744	0	0.0	Sb121
1	511220	0.0000	0	0.0	Sb122
1	511230	0.2070	0	0.0	Sb123
1	521200	0.0848	0	0.0	Te120
1	521210	0.0000	0	0.0	Te121
1	521220	2.3493	0	0.0	Te122
1	521230	0.8276	0	0.0	Te123
1	521240	4.4161	0	0.0	Te124
1	521250	6.6171	0	0.0	Te125
1	521260	17.7337	0	0.0	Te126
1	521270	0.0000	0	0.0	Te127
1	521280	30.1680	0	0.0	Te128
1	521290	0.0000	0	0.0	Te129
1	521300	32.7368	0	0.0	Te130
1	531270	20.0000	0	0.0	I127
1	541240	1.0142	0	0.0	Xe124
1	541250	0.0000	0	0.0	Xe125
1	541260	0.9275	0	0.0	Xe126
1	541270	0.0000	0	0.0	Xe127
1	541280	19.9968	0	0.0	Xe128
1	541290	278.5551	0	0.0	Xe129
1	541300	43.5958	0	0.0	Xe130
1	541310	227.1562	0	0.0	Xe131
1	541320	290.4314	0	0.0	Xe132
1	541330	0.0000	0	0.0	Xe133
1	541340	113.9871	0	0.0	Xe134
1	541350	0.0000	0	0.0	Xe135
1	541360	99.0025	0	0.0	Xe136
1	551330	0.4027	0	0.0	Cs133
1	561300	0.0120	0	0.0	Ba130
1	561310	0.0000	0	0.0	Ba131
1	561320	0.0116	0	0.0	Ba132
1	561330	0.0000	0	0.0	Ba133
1	561340	0.2832	0	0.0	Ba134

1	561350	0.7772	0	0.0	Ba135
1	561360	0.9323	0	0.0	Ba136
1	561370	1.3435	0	0.0	Ba137
1	561380	8.6402	0	0.0	Ba138
1	571380	0.0018	0	0.0	La138
1	571390	1.9982	0	0.0	La139
1	581360	0.0037	0	0.0	Ce136
1	581370	0.0000	0	0.0	Ce137
1	581380	0.0049	0	0.0	Ce138
1	581390	0.0000	0	0.0	Ce139
1	581400	1.7659	0	0.0	Ce140
1	581410	0.0000	0	0.0	Ce141
1	581420	0.2254	0	0.0	Ce142
1	591410	2.0000	0	0.0	Pr141
1	601420	2.6692	0	0.0	Nd142
1	601430	1.2068	0	0.0	Nd143
1	601440	2.3745	0	0.0	Nd144
1	601450	0.8338	0	0.0	Nd145
1	601460	1.7389	0	0.0	Nd146
1	601470	0.0000	0	0.0	Nd147
1	601480	0.5906	0	0.0	Nd148
1	601490	0.0000	0	0.0	Nd149
1	601500	0.5862	0	0.0	Nd150
1	611450	0.0000	0	0.0	Pm145
1	621440	0.0297	0	0.0	Sm144
1	621450	0.0000	0	0.0	Sm145
1	621460	0.0000	0	0.0	Sm146
1	621470	0.1466	0	0.0	Sm147
1	621480	0.1112	0	0.0	Sm148
1	621490	0.1367	0	0.0	Sm149
1	621500	0.0738	0	0.0	Sm150
1	621510	0.0000	0	0.0	Sm151
1	621520	0.2698	0	0.0	Sm152
1	621530	0.0000	0	0.0	Sm153
1	621540	0.2324	0	0.0	Sm154
1	631510	0.4747	0	0.0	Eu151
1	631520	0.0000	0	0.0	Eu152
1	631530	0.5253	0	0.0	Eu153
1	641520	0.0008	0	0.0	Gd152
1	641530	0.0000	0	0.0	Gd153
1	641540	0.0085	0	0.0	Gd154
1	641550	0.0583	0	0.0	Gd155
1	641560	0.0812	0	0.0	Gd156
1	641570	0.0625	0	0.0	Gd157
1	641580	0.0998	0	0.0	Gd158
1	641590	0.0000	0	0.0	Gd159
1	641600	0.0889	0	0.0	Gd160
1	651590	2.0000	0	0.0	Tb159
1	661560	0.0002	0	0.0	Dy156
1	661570	0.0000	0	0.0	Dy157
1	661580	0.0004	0	0.0	Dy158
1	661590	0.0000	0	0.0	Dy159
1	661600	0.0092	0	0.0	Dy160
1	661610	0.0749	0	0.0	Dy161
1	661620	0.1016	0	0.0	Dy162
1	661630	0.0999	0	0.0	Dy163
1	661640	0.1138	0	0.0	Dy164
1	671650	2.0000	0	0.0	Ho165
1	681620	0.0014	0	0.0	Er162
1	681630	0.0000	0	0.0	Er163
1	681640	0.0158	0	0.0	Er164
1	681650	0.0000	0	0.0	Er165
1	681660	0.3333	0	0.0	Er166

1	681670	0.2291	0	0.0	Er167
1	681680	0.2691	0	0.0	Er168
1	681690	0.0000	0	0.0	Er169
1	681700	0.1514	0	0.0	Er170
1	691690	1.0000	0	0.0	Tm169
1	701680	0.0005	0	0.0	Yb168
1	701690	0.0000	0	0.0	Yb169
1	701700	0.0120	0	0.0	Yb170
1	701710	0.0565	0	0.0	Yb171
1	701720	0.0870	0	0.0	Yb172
1	701730	0.0644	0	0.0	Yb173
1	701740	0.1279	0	0.0	Yb174
1	701750	0.0000	0	0.0	Yb175
1	701760	0.0517	0	0.0	Yb176
1	711750	1.2986	0	0.0	Lu175
1	711760	0.0347	0	0.0	Lu176
1	721740	0.0013	0	0.0	Hf174
1	721750	0.0000	0	0.0	Hf175
1	721760	0.0435	0	0.0	Hf176
1	721770	0.1562	0	0.0	Hf177
1	721780	0.2304	0	0.0	Hf178
1	721790	0.1157	0	0.0	Hf179
1	721800	0.2996	0	0.0	Hf180
1	731801	0.0001	0	0.0	Ta180M
1	731810	0.8659	0	0.0	Ta181
1	741800	0.1790	0	0.0	W180
1	741810	0.0000	0	0.0	W181
1	741820	39.6747	0	0.0	W182
1	741830	21.6604	0	0.0	W183
1	741840	46.8212	0	0.0	W184
1	741850	0.0000	0	0.0	W185
1	741860	44.0926	0	0.0	W186
1	751850	0.4785	0	0.0	Re185
1	751860	0.0000	0	0.0	Re186
1	751870	0.8095	0	0.0	Re187
1	761840	0.0002	0	0.0	Os184
1	761850	0.0000	0	0.0	Os185
1	761860	0.0197	0	0.0	Os186
1	761870	0.0200	0	0.0	Os187
1	761880	0.1674	0	0.0	Os188
1	761890	0.2037	0	0.0	Os189
1	761900	0.3358	0	0.0	Os190
1	761910	0.0000	0	0.0	Os191
1	761920	0.5271	0	0.0	Os192
1	771910	0.0037	0	0.0	Ir191
1	771920	0.0000	0	0.0	Ir192
1	771930	0.0063	0	0.0	Ir193
1	781900	0.0198	0	0.0	Pt190
1	781910	0.0000	0	0.0	Pt191
1	781920	1.5838	0	0.0	Pt192
1	781930	0.0000	0	0.0	Pt193
1	781940	66.6452	0	0.0	Pt194
1	781950	68.8212	0	0.0	Pt195
1	781960	51.7783	0	0.0	Pt196
1	781970	0.0000	0	0.0	Pt197
1	781980	14.8857	0	0.0	Pt198
1	791970	49.6000	0	0.0	Au197
1	801960	0.0119	0	0.0	Hg196
1	801970	0.0000	0	0.0	Hg197
1	801980	0.8039	0	0.0	Hg198
1	801990	1.3655	0	0.0	Hg199
1	802000	1.8758	0	0.0	Hg200
1	802010	1.0773	0	0.0	Hg201

1	802020	2.4441	0	0.0	Hg202
1	802030	0.0000	0	0.0	Hg203
1	802040	0.5674	0	0.0	Hg204
1	812030	14.6582	0	0.0	Tl203
1	812040	0.0000	0	0.0	Tl204
1	812050	35.3418	0	0.0	Tl205
1	822040	0.0276	0	0.0	Pb204
1	822050	0.0000	0	0.0	Pb205
1	822060	0.4791	0	0.0	Pb206
1	822070	0.4415	0	0.0	Pb207
1	822080	1.0518	0	0.0	Pb208
1	832090	0.0000	0	0.0	Bi209
2	902320	0.8760	0	0.0	Th232
2	922340	0.0032	0	0.0	U234
2	922350	0.4266	0	0.0	U235
2	922360	0.0000	0	0.0	U236
2	922370	0.0000	0	0.0	U237
2	922380	59.5702	0	0.0	U238
0					

Appendix F

**Oak Ridge Isotope GENeration and Depletion Code Version 2
Input Model for the Engineering Test Reactor
Beryllium Reflector from Core 1**

Appendix F

Oak Ridge Isotope GENeration and Depletion Code Version 2 Input Model for the Engineering Test Reactor Beryllium Reflector from Core 1

Appendix E is a listing of the input file used with the Oak Ridge Isotope GENeration and Depletion Code Version 2 to model activation and transmutation in the beryllium reflector used for Core 1 of the Engineering Test Reactor (ETR).

```
-1
-1
-1
TIT EETR - Beryllium Block Inventory (CURIES) 1/31/2003
TIT IINPUT: BE_ETR1.inp ACTIVATION ANALYSIS
TIT OOUTPUT: BE_ETR1.out INCLUDES NEW XS SET
TIT
TIT CCOMPONENT: Total ETR Beryllium Block Inventory
TIT LLOCATION: ETR BLOCKS for 624 kg
TIT IIRARADIATION: 10/15/57 - 3/1/70 for 4,520 days
TIT
TIT MMATERIAL: Beryllium Metal
TIT MMATERIAL MASS: 624,000 grams of Be including other trace elements
BAS
LIP 0 0 0
LPU 30060 40090
      60120 60130 70140 80170 270590
      270600 270601 280580 280590 280600
      280610 280620 280630 280640 290630
      300660 410930 410940 420940 420980
      420990 430990           -1
LPU 902320 902330 912330 922330 922340
      922350 922360 922370 922380 922390
      922400 932350 932360 932370 932380
      942370 942380 942390 942400 942410
      942420 942430 952410 952420 952430
      962420 962430 962440 962450 962460
      962470 962480 972490 982490 982500
      982510 982520           -1
LIB 0 1 2 3 -204 -908 909    9 50 0 4 0
PHO 101 102 103 10
RDA -----
RDA * All Beryllium Blocks for ETR Core 1
RDA * 1957-1970 (or 4,520-day irradiation from 10/15/1957=Day #21108)
RDA * Decay Time: 0 days = Scram on March 1, 1970
RDA * Decay Time: 4,520+60 = 4,580 days=April 30, 1970 Est. disposal date
RDA * Decay Time: 4,520+11,521 = 16,041 days = Sept 15, 2001
RDA -----
OPTL 8 8 8 8 2   8 2 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTA 8 8 8 8 2   8 2 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTF 8 8 8 8 2   8 2 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
CUT      7 1.0E-06      28 1.0E-75   -1
INP -1 1 -1 -1 1           Read 2E6 g input to vector -1
MOV -1 1 0 0.312          Change input of Be to 624,000 g
BUP
RDA Est total flux to power ratio in the ETR reflector is 4.93E14/175 MW
RDA ETR total exposure = 380,000 MWD over 4,520 D => 84.07 MW per day
IRF 500.0      2.368E+14  1 2 4 2 at 84.07 MW
```

IRF 1000.0 2.368E+14 2 3 4 0 at 84.07 MW
 IRF 1500.0 2.368E+14 3 4 4 0 at 84.07 MW
 IRF 2000.0 2.368E+14 4 5 4 0 at 84.07 MW
 IRF 2500.0 2.368E+14 5 6 4 0 at 84.07 MW
 IRF 3000.0 2.368E+14 6 7 4 0 at 84.07 MW
 IRF 3500.0 2.368E+14 7 8 4 0 at 84.07 MW
 IRF 4000.0 2.368E+14 8 9 4 0 at 84.07 MW
 IRF 4520.0 2.368E+14 9 10 4 0 at 84.07 MW EOI 3/1/1970
 MOV 9 2 0 1.0
 MOV 10 3 0 1.0
 DEC 4580.0 3 4 4 0 Est disposal date 4/30/1970
 DEC 16041.0 4 5 4 0 Common date Sept 15, 2001
 HED 3 MAR1970
 HED 4 APR1970
 HED 5 SEP2001
 OUT 5 1 0 0
 STP 4
 204 30060 8.483E-03 0.000E+00 2.063E+02 7.452E-04 0.000E+00 0.000E+00 -1.0
 204 40090 1.948E-03 2.080E-02 7.427E-03 0.000E+00 0.000E+00 0.000E+00 -1.0
 204 60120 1.142E-03 0.000E+00 1.003E-04 0.000E+00 0.000E+00 0.000E+00 -1.0
 204 60130 2.060E-04 4.540E-05 7.969E-04 0.000E+00 0.000E+00 0.000E+00 -1.0
 204 70140 1.660E-02 0.000E+00 1.692E-02 4.195E-01 0.000E+00 0.000E+00 -1.0
 204 80170 0.000E+00 0.000E+00 7.786E-02 0.000E+00 0.000E+00 0.000E+00 -1.0
 204 270590 5.743E+00 0.000E+00 2.786E-05 2.632E-04 2.622E+00 0.000E+00 -1.0
 204 270600 5.549E-01 0.000E+00 1.108E-05 4.447E-05 0.000E+00 0.000E+00 -1.0
 204 270601 1.767E+01 0.000E+00 2.068E-05 3.162E-04 0.000E+00 0.000E+00 -1.0
 204 280580 1.018E+00 2.491E-06 3.127E-03 9.706E-03 0.000E+00 0.000E+00 -1.0
 204 280590 2.296E+01 0.000E+00 4.436E+00 2.112E-02 0.000E+00 0.000E+00 -1.0
 204 280600 6.251E-01 2.200E-06 6.871E-04 5.211E-04 0.000E+00 0.000E+00 -1.0
 204 280610 5.730E-01 0.000E+00 1.262E-03 4.781E-04 0.000E+00 0.000E+00 -1.0
 204 280620 3.129E+00 0.000E+00 2.113E-05 3.065E-05 0.000E+00 0.000E+00 -1.0
 204 280630 5.072E+00 0.000E+00 2.415E-05 5.060E-06 0.000E+00 0.000E+00 -1.0
 204 280640 3.377E-01 4.075E-05 1.010E-06 2.838E-07 0.000E+00 0.000E+00 -1.0
 204 290630 1.109E+00 0.000E+00 4.053E-05 4.417E-03 0.000E+00 0.000E+00 -1.0
 204 300660 2.151E-01 0.000E+00 2.641E-06 8.900E-05 0.000E+00 0.000E+00 -1.0
 204 410930 5.213E-01 0.000E+00 1.057E-05 6.672E-05 1.012E-01 0.000E+00 -1.0
 204 410940 6.651E+00 0.000E+00 0.000E+00 1.006E-04 0.000E+00 0.000E+00 -1.0
 204 420940 2.676E-01 0.000E+00 2.023E-04 8.577E-05 0.000E+00 0.000E+00 -1.0
 204 420980 2.359E-01 0.000E+00 2.023E-05 2.450E-06 0.000E+00 0.000E+00 -1.0
 204 420990 8.793E-01 2.085E-03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 -1.0
 204 430990 1.254E+01 0.000E+00 0.000E+00 2.643E-04 0.000E+00 0.000E+00 -1.0
 908 902320 4.053E+00 2.847E-03 3.904E-06 1.560E-02 0.000E+00 0.000E+00 -1.0
 908 902330 2.970E+02 1.326E-02 2.515E-05 5.525E+00 0.000E+00 0.000E+00 -1.0
 908 912330 3.147E+01 8.192E-04 1.223E-07 9.902E-02 1.234E+01 0.000E+00 -1.0
 908 922330 1.375E+01 9.849E-04 0.000E+00 1.309E+02 0.000E+00 0.000E+00 -1.0
 908 922340 3.774E+01 2.681E-04 5.126E-08 4.346E-01 0.000E+00 0.000E+00 -1.0
 908 922350 2.396E+01 1.416E-03 7.930E-08 1.248E+02 0.000E+00 0.000E+00 -1.0
 908 922360 1.078E+01 1.509E-03 2.759E-06 2.655E-01 0.000E+00 0.000E+00 -1.0
 908 922370 1.055E+02 4.314E-03 1.097E-05 8.004E-01 0.000E+00 0.000E+00 -1.0
 908 922380 8.514E+00 2.830E-03 2.124E-06 6.451E-02 0.000E+00 0.000E+00 -1.0
 908 922390 8.960E+00 1.181E-02 4.250E-05 1.042E+01 0.000E+00 0.000E+00 -1.0
 908 922400 5.799E+00 6.156E-03 4.681E-05 4.871E-02 0.000E+00 0.000E+00 -1.0
 908 932350 3.759E+02 7.520E-04 0.000E+00 3.793E-01 1.472E+02 0.000E+00 -1.0
 908 932360 2.266E+01 2.270E-03 1.285E-07 5.810E+02 0.000E+00 0.000E+00 -1.0
 908 932370 6.185E+01 2.586E-04 4.320E-08 3.535E-01 0.000E+00 2.248E-04 -1.0
 908 932380 2.266E+01 2.674E-03 1.030E-06 4.804E+02 0.000E+00 0.000E+00 -1.0
 908 942370 1.259E+02 9.328E-04 0.000E+00 6.586E+02 0.000E+00 0.000E+00 -1.0
 908 942380 1.108E+02 7.726E-04 1.072E-07 4.462E+00 0.000E+00 0.000E+00 -1.0
 908 942390 1.001E+02 5.948E-04 1.280E-08 2.129E+02 0.000E+00 0.000E+00 -1.0
 908 942400 2.870E+02 2.639E-04 1.820E-07 4.323E-01 0.000E+00 0.000E+00 -1.0
 908 942410 9.347E+01 3.833E-03 1.294E-06 2.598E+02 0.000E+00 0.000E+00 -1.0
 908 942420 3.533E+01 1.170E-03 6.160E-07 2.934E-01 0.000E+00 0.000E+00 -1.0
 908 942430 6.342E+01 9.415E-03 2.205E-05 5.155E+01 0.000E+00 0.000E+00 -1.0

908	952410	1.967E+02	2.155E-04	1.014E-07	1.395E+00	1.084E+01	0.000E+00	-1.0
908	952420	3.336E+02	2.167E-03	1.333E-06	1.647E+03	0.000E+00	0.000E+00	-1.0
908	952430	6.742E+01	1.385E-04	2.613E-08	2.855E-01	5.416E+01	0.000E+00	-1.0
908	962420	8.458E+00	3.412E-05	0.000E+00	8.529E-01	0.000E+00	0.000E+00	-1.0
908	962430	8.037E+01	3.600E-03	1.135E-06	1.650E+02	0.000E+00	0.000E+00	-1.0
908	962440	2.037E+01	6.956E-04	7.324E-07	8.641E-01	0.000E+00	0.000E+00	-1.0
908	962450	8.037E+01	3.754E-03	1.740E-06	4.055E+02	0.000E+00	0.000E+00	-1.0
908	962460	4.296E+00	3.117E-03	8.592E-06	4.185E-01	0.000E+00	0.000E+00	-1.0
908	962470	2.862E+01	5.672E-03	9.587E-06	4.261E+01	0.000E+00	0.000E+00	-1.0
908	962480	8.549E+00	3.385E-03	2.084E-05	6.770E-01	0.000E+00	0.000E+00	-1.0
908	972490	4.474E+02	3.844E-03	1.072E-05	4.325E-01	0.000E+00	0.000E+00	-1.0
908	982490	1.066E+02	3.958E-03	9.771E-06	3.958E+02	0.000E+00	0.000E+00	-1.0
908	982500	7.566E+02	2.041E-03	4.272E-06	7.161E-01	0.000E+00	0.000E+00	-1.0
908	982510	6.595E+02	6.666E-03	1.017E-05	7.864E+02	0.000E+00	0.000E+00	-1.0
908	982520	5.804E+00	1.587E-03	7.279E-06	1.057E+01	0.000E+00	0.000E+00	-1.0
1	10010	0.0000	0	0.0	H1			
1	10020	0.0000	0	0.0	H2			
1	20030	0.0000	0	0.0	He3			
1	20040	0.0000	0	0.0	He4			
1	30060	0.0000	0	0.0	Li6			
1	30070	2.0000	0	0.0	Li7			
1	40090	1961335.6700	0	0.0	Be9			
1	40100	0.0000	0	0.0	Be10			
1	50100	0.7065	0	0.0	B10			
1	50110	3.1268	0	0.0	B11			
1	60120	1472.2559	0	0.0	C12			
1	60130	17.7441	0	0.0	C13			
1	70140	409.1719	0	0.0	N14			
1	70150	1.6281	0	0.0	N15			
1	80160	25169.8420	0	0.0	O16			
1	80170	10.7229	0	0.0	O17			
1	80180	56.7684	0	0.0	O18			
1	90190	138.3333	0	0.0	F19			
1	100200	2554.7041	0	0.0	Ne20			
1	100210	8.0046	0	0.0	Ne21			
1	100220	287.2913	0	0.0	Ne22			
1	110230	1.7487	0	0.0	Na23			
1	120240	70.1550	0	0.0	Mg24			
1	120250	9.2516	0	0.0	Mg25			
1	120260	10.5934	0	0.0	Mg26			
1	130270	711.6667	0	0.0	Al27			
1	140280	568.8058	0	0.0	Si28			
1	140290	74.5816	0	0.0	Si29			
1	140300	84.9459	0	0.0	Si30			
1	150310	100.0000	0	0.0	P31			
1	160320	14.2119	0	0.0	S32			
1	160330	0.1157	0	0.0	S33			
1	160340	0.6690	0	0.0	S34			
1	160350	0.0000	0	0.0	S35			
1	160360	0.0034	0	0.0	S36			
1	170350	74.7352	0	0.0	C135			
1	170360	0.0000	0	0.0	C136			
1	170370	25.2648	0	0.0	C137			
1	180360	0.0387	0	0.0	Ar36			
1	180370	0.0000	0	0.0	Ar37			
1	180380	0.0076	0	0.0	Ar38			
1	180390	0.0000	0	0.0	Ar39			
1	180400	12.6937	0	0.0	Ar40			
1	190390	24.2937	0	0.0	K39			
1	190400	0.0031	0	0.0	K40			
1	190410	1.8431	0	0.0	K41			
1	200400	386.6463	0	0.0	Ca40			
1	200410	0.0000	0	0.0	Ca41			

1	200420	2.7096	0	0.0	Ca42
1	200430	0.5788	0	0.0	Ca43
1	200440	9.1519	0	0.0	Ca44
1	200450	0.0000	0	0.0	Ca45
1	200460	0.0183	0	0.0	Ca46
1	200470	0.0000	0	0.0	Ca47
1	200480	0.8950	0	0.0	Ca48
1	210450	4.6000	0	0.0	Sc45
1	220460	9.4694	0	0.0	Ti46
1	220470	8.8286	0	0.0	Ti47
1	220480	91.1529	0	0.0	Ti48
1	220490	6.9348	0	0.0	Ti49
1	220500	6.9476	0	0.0	Ti50
1	230500	0.0168	0	0.0	V50
1	230510	6.8299	0	0.0	V51
1	240500	7.7209	0	0.0	Cr50
1	240510	0.0000	0	0.0	Cr51
1	240520	154.8465	0	0.0	Cr52
1	240530	17.8939	0	0.0	Cr53
1	240540	4.5387	0	0.0	Cr54
1	250550	113.3333	0	0.0	Mn55
1	260540	170.8626	0	0.0	Fe54
1	260550	0.0000	0	0.0	Fe55
1	260560	2754.5672	0	0.0	Fe56
1	260570	64.1941	0	0.0	Fe57
1	260580	8.7094	0	0.0	Fe58
1	270590	24.0000	0	0.0	Co59
1	280580	304.3952	0	0.0	Ni58
1	280590	0.0000	0	0.0	Ni59
1	280600	120.3848	0	0.0	Ni60
1	280610	5.2989	0	0.0	Ni61
1	280620	17.1106	0	0.0	Ni62
1	280630	0.0000	0	0.0	Ni63
1	280640	4.4771	0	0.0	Ni64
1	290630	119.8743	0	0.0	Cu63
1	290640	0.0000	0	0.0	Cu64
1	290650	55.1257	0	0.0	Cu65
1	300640	12.3525	0	0.0	Zn64
1	300650	0.0000	0	0.0	Zn65
1	300660	7.3128	0	0.0	Zn66
1	300670	1.0909	0	0.0	Zn67
1	300680	5.0770	0	0.0	Zn68
1	300690	0.0000	0	0.0	Zn69
1	300700	0.1668	0	0.0	Zn70
1	310690	1.0213	0	0.0	Ga69
1	310700	0.0000	0	0.0	Ga70
1	310710	0.6974	0	0.0	Ga71
1	320700	1.9736	0	0.0	Ge70
1	320710	0.0000	0	0.0	Ge71
1	320720	2.7132	0	0.0	Ge72
1	320730	0.7831	0	0.0	Ge73
1	320740	3.7148	0	0.0	Ge74
1	320750	0.0000	0	0.0	Ge75
1	320760	0.8153	0	0.0	Ge76
1	330750	3.5640	0	0.0	As75
1	340740	0.0402	0	0.0	Se74
1	340750	0.0000	0	0.0	Se75
1	340760	0.4170	0	0.0	Se76
1	340770	0.3528	0	0.0	Se77
1	340780	1.1099	0	0.0	Se78
1	340790	0.0000	0	0.0	Se79
1	340800	2.4068	0	0.0	Se80
1	340810	0.0000	0	0.0	Se81

1	340820	0.4400	0	0.0	Se82
1	350790	52.0676	0	0.0	Br79
1	350800	0.0000	0	0.0	Br80
1	350810	51.9324	0	0.0	Br81
1	360780	0.5543	0	0.0	Kr78
1	360790	0.0000	0	0.0	Kr79
1	360800	3.6549	0	0.0	Kr80
1	360810	0.0000	0	0.0	Kr81
1	360820	19.3140	0	0.0	Kr82
1	360830	19.3810	0	0.0	Kr83
1	360840	97.2196	0	0.0	Kr84
1	360850	0.0000	0	0.0	Kr85
1	360860	30.2096	0	0.0	Kr86
1	370850	11.1359	0	0.0	Rb85
1	370860	0.0000	0	0.0	Rb86
1	370870	4.3974	0	0.0	Rb87
1	380840	0.0644	0	0.0	Sr84
1	380850	0.0000	0	0.0	Sr85
1	380860	1.1601	0	0.0	Sr86
1	380870	0.8332	0	0.0	Sr87
1	380880	9.9423	0	0.0	Sr88
1	390890	2.0000	0	0.0	Y89
1	400900	38.7548	0	0.0	Zr90
1	400910	8.5454	0	0.0	Zr91
1	400920	13.2053	0	0.0	Zr92
1	400930	0.0000	0	0.0	Zr93
1	400940	13.6734	0	0.0	Zr94
1	400950	0.0000	0	0.0	Zr95
1	400960	2.2497	0	0.0	Zr96
1	410930	23.4000	0	0.0	Nb93
1	420920	2.8436	0	0.0	Mo92
1	420930	0.0000	0	0.0	Mo93
1	420940	1.8110	0	0.0	Mo94
1	420950	3.1500	0	0.0	Mo95
1	420960	3.3351	0	0.0	Mo96
1	420970	1.9294	0	0.0	Mo97
1	420980	4.9252	0	0.0	Mo98
1	420990	0.0000	0	0.0	Mo99
1	421000	2.0057	0	0.0	Mo100
1	430990	0.0000	0	0.0	Tc99
1	440960	0.5257	0	0.0	Ru96
1	440970	0.0000	0	0.0	Ru97
1	440980	0.1802	0	0.0	Ru98
1	440990	1.2429	0	0.0	Ru99
1	441000	1.2455	0	0.0	Ru100
1	441010	1.7073	0	0.0	Ru101
1	441020	3.1862	0	0.0	Ru102
1	441030	0.0000	0	0.0	Ru103
1	441040	1.9122	0	0.0	Ru104
1	451030	1.9873	0	0.0	Rh103
1	461020	0.0977	0	0.0	Pd102
1	461030	0.0000	0	0.0	Pd103
1	461040	1.0877	0	0.0	Pd104
1	461050	2.2013	0	0.0	Pd105
1	461060	2.7199	0	0.0	Pd106
1	461070	0.0000	0	0.0	Pd107
1	461080	2.6830	0	0.0	Pd108
1	461090	0.0000	0	0.0	Pd109
1	461100	1.2104	0	0.0	Pd110
1	471070	2.2263	0	0.0	Ag107
1	471080	0.0000	0	0.0	Ag108
1	471090	2.1070	0	0.0	Ag109
1	481060	0.0236	0	0.0	Cd106

1	481070	0.0000	0	0.0	Cd107
1	481080	0.0171	0	0.0	Cd108
1	481090	0.0000	0	0.0	Cd109
1	481100	0.2442	0	0.0	Cd110
1	481110	0.2526	0	0.0	Cd111
1	481120	0.4804	0	0.0	Cd112
1	481130	0.2455	0	0.0	Cd113
1	481140	0.5822	0	0.0	Cd114
1	481150	0.0000	0	0.0	Cd115
1	481160	0.1544	0	0.0	Cd116
1	491130	0.0058	0	0.0	In113
1	491140	0.0000	0	0.0	In114
1	491150	0.1313	0	0.0	In115
1	501120	0.0549	0	0.0	Sn112
1	501130	0.0000	0	0.0	Sn113
1	501140	0.0374	0	0.0	Sn114
1	501150	0.0209	0	0.0	Sn115
1	501160	0.8512	0	0.0	Sn116
1	501170	0.4538	0	0.0	Sn117
1	501180	1.4433	0	0.0	Sn118
1	501190	0.5156	0	0.0	Sn119
1	501200	1.9750	0	0.0	Sn120
1	501210	0.0000	0	0.0	Sn121
1	501220	0.2853	0	0.0	Sn122
1	501230	0.0000	0	0.0	Sn123
1	501240	0.3626	0	0.0	Sn124
1	511210	0.2744	0	0.0	Sb121
1	511220	0.0000	0	0.0	Sb122
1	511230	0.2070	0	0.0	Sb123
1	521200	0.0848	0	0.0	Te120
1	521210	0.0000	0	0.0	Te121
1	521220	2.3493	0	0.0	Te122
1	521230	0.8276	0	0.0	Te123
1	521240	4.4161	0	0.0	Te124
1	521250	6.6171	0	0.0	Te125
1	521260	17.7337	0	0.0	Te126
1	521270	0.0000	0	0.0	Te127
1	521280	30.1680	0	0.0	Te128
1	521290	0.0000	0	0.0	Te129
1	521300	32.7368	0	0.0	Te130
1	531270	20.0000	0	0.0	I127
1	541240	1.0142	0	0.0	Xe124
1	541250	0.0000	0	0.0	Xe125
1	541260	0.9275	0	0.0	Xe126
1	541270	0.0000	0	0.0	Xe127
1	541280	19.9968	0	0.0	Xe128
1	541290	278.5551	0	0.0	Xe129
1	541300	43.5958	0	0.0	Xe130
1	541310	227.1562	0	0.0	Xe131
1	541320	290.4314	0	0.0	Xe132
1	541330	0.0000	0	0.0	Xe133
1	541340	113.9871	0	0.0	Xe134
1	541350	0.0000	0	0.0	Xe135
1	541360	99.0025	0	0.0	Xe136
1	551330	0.4027	0	0.0	Cs133
1	561300	0.0120	0	0.0	Ba130
1	561310	0.0000	0	0.0	Ba131
1	561320	0.0116	0	0.0	Ba132
1	561330	0.0000	0	0.0	Ba133
1	561340	0.2832	0	0.0	Ba134
1	561350	0.7772	0	0.0	Ba135
1	561360	0.9323	0	0.0	Ba136
1	561370	1.3435	0	0.0	Ba137

1	561380	8.6402	0	0.0	Ba138
1	571380	0.0018	0	0.0	La138
1	571390	1.9982	0	0.0	La139
1	581360	0.0037	0	0.0	Ce136
1	581370	0.0000	0	0.0	Ce137
1	581380	0.0049	0	0.0	Ce138
1	581390	0.0000	0	0.0	Ce139
1	581400	1.7659	0	0.0	Ce140
1	581410	0.0000	0	0.0	Ce141
1	581420	0.2254	0	0.0	Ce142
1	591410	2.0000	0	0.0	Pr141
1	601420	2.6692	0	0.0	Nd142
1	601430	1.2068	0	0.0	Nd143
1	601440	2.3745	0	0.0	Nd144
1	601450	0.8338	0	0.0	Nd145
1	601460	1.7389	0	0.0	Nd146
1	601470	0.0000	0	0.0	Nd147
1	601480	0.5906	0	0.0	Nd148
1	601490	0.0000	0	0.0	Nd149
1	601500	0.5862	0	0.0	Nd150
1	611450	0.0000	0	0.0	Pm145
1	621440	0.0297	0	0.0	Sm144
1	621450	0.0000	0	0.0	Sm145
1	621460	0.0000	0	0.0	Sm146
1	621470	0.1466	0	0.0	Sm147
1	621480	0.1112	0	0.0	Sm148
1	621490	0.1367	0	0.0	Sm149
1	621500	0.0738	0	0.0	Sm150
1	621510	0.0000	0	0.0	Sm151
1	621520	0.2698	0	0.0	Sm152
1	621530	0.0000	0	0.0	Sm153
1	621540	0.2324	0	0.0	Sm154
1	631510	0.4747	0	0.0	Eu151
1	631520	0.0000	0	0.0	Eu152
1	631530	0.5253	0	0.0	Eu153
1	641520	0.0008	0	0.0	Gd152
1	641530	0.0000	0	0.0	Gd153
1	641540	0.0085	0	0.0	Gd154
1	641550	0.0583	0	0.0	Gd155
1	641560	0.0812	0	0.0	Gd156
1	641570	0.0625	0	0.0	Gd157
1	641580	0.0998	0	0.0	Gd158
1	641590	0.0000	0	0.0	Gd159
1	641600	0.0889	0	0.0	Gd160
1	651590	2.0000	0	0.0	Tb159
1	661560	0.0002	0	0.0	Dy156
1	661570	0.0000	0	0.0	Dy157
1	661580	0.0004	0	0.0	Dy158
1	661590	0.0000	0	0.0	Dy159
1	661600	0.0092	0	0.0	Dy160
1	661610	0.0749	0	0.0	Dy161
1	661620	0.1016	0	0.0	Dy162
1	661630	0.0999	0	0.0	Dy163
1	661640	0.1138	0	0.0	Dy164
1	671650	2.0000	0	0.0	Ho165
1	681620	0.0014	0	0.0	Er162
1	681630	0.0000	0	0.0	Er163
1	681640	0.0158	0	0.0	Er164
1	681650	0.0000	0	0.0	Er165
1	681660	0.3333	0	0.0	Er166
1	681670	0.2291	0	0.0	Er167
1	681680	0.2691	0	0.0	Er168
1	681690	0.0000	0	0.0	Er169

1	681700	0.1514	0	0.0	Er170
1	691690	1.0000	0	0.0	Tm169
1	701680	0.0005	0	0.0	Yb168
1	701690	0.0000	0	0.0	Yb169
1	701700	0.0120	0	0.0	Yb170
1	701710	0.0565	0	0.0	Yb171
1	701720	0.0870	0	0.0	Yb172
1	701730	0.0644	0	0.0	Yb173
1	701740	0.1279	0	0.0	Yb174
1	701750	0.0000	0	0.0	Yb175
1	701760	0.0517	0	0.0	Yb176
1	711750	1.2986	0	0.0	Lu175
1	711760	0.0347	0	0.0	Lu176
1	721740	0.0013	0	0.0	Hf174
1	721750	0.0000	0	0.0	Hf175
1	721760	0.0435	0	0.0	Hf176
1	721770	0.1562	0	0.0	Hf177
1	721780	0.2304	0	0.0	Hf178
1	721790	0.1157	0	0.0	Hf179
1	721800	0.2996	0	0.0	Hf180
1	731801	0.0001	0	0.0	Ta180M
1	731810	0.8659	0	0.0	Ta181
1	741800	0.1790	0	0.0	W180
1	741810	0.0000	0	0.0	W181
1	741820	39.6747	0	0.0	W182
1	741830	21.6604	0	0.0	W183
1	741840	46.8212	0	0.0	W184
1	741850	0.0000	0	0.0	W185
1	741860	44.0926	0	0.0	W186
1	751850	0.4785	0	0.0	Re185
1	751860	0.0000	0	0.0	Re186
1	751870	0.8095	0	0.0	Re187
1	761840	0.0002	0	0.0	Os184
1	761850	0.0000	0	0.0	Os185
1	761860	0.0197	0	0.0	Os186
1	761870	0.0200	0	0.0	Os187
1	761880	0.1674	0	0.0	Os188
1	761890	0.2037	0	0.0	Os189
1	761900	0.3358	0	0.0	Os190
1	761910	0.0000	0	0.0	Os191
1	761920	0.5271	0	0.0	Os192
1	771910	0.0037	0	0.0	Ir191
1	771920	0.0000	0	0.0	Ir192
1	771930	0.0063	0	0.0	Ir193
1	781900	0.0198	0	0.0	Pt190
1	781910	0.0000	0	0.0	Pt191
1	781920	1.5838	0	0.0	Pt192
1	781930	0.0000	0	0.0	Pt193
1	781940	66.6452	0	0.0	Pt194
1	781950	68.8212	0	0.0	Pt195
1	781960	51.7783	0	0.0	Pt196
1	781970	0.0000	0	0.0	Pt197
1	781980	14.8857	0	0.0	Pt198
1	791970	49.6000	0	0.0	Au197
1	801960	0.0119	0	0.0	Hg196
1	801970	0.0000	0	0.0	Hg197
1	801980	0.8039	0	0.0	Hg198
1	801990	1.3655	0	0.0	Hg199
1	802000	1.8758	0	0.0	Hg200
1	802010	1.0773	0	0.0	Hg201
1	802020	2.4441	0	0.0	Hg202
1	802030	0.0000	0	0.0	Hg203
1	802040	0.5674	0	0.0	Hg204

1	812030	14.6582	0	0.0	Tl203
1	812040	0.0000	0	0.0	Tl204
1	812050	35.3418	0	0.0	Tl205
1	822040	0.0276	0	0.0	Pb204
1	822050	0.0000	0	0.0	Pb205
1	822060	0.4791	0	0.0	Pb206
1	822070	0.4415	0	0.0	Pb207
1	822080	1.0518	0	0.0	Pb208
1	832090	0.0000	0	0.0	Bi209
2	902320	0.8760	0	0.0	Th232
2	922340	0.0032	0	0.0	U234
2	922350	0.4266	0	0.0	U235
2	922360	0.0000	0	0.0	U236
2	922370	0.0000	0	0.0	U237
2	922380	59.5702	0	0.0	U238
0					